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Buccola et al.

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(45) **Date of Patent: Nov. 30, 2021**

(54) **POWER ASSIST MODULE FOR COVERINGS FOR ARCHITECTURAL STRUCTURES AND RELATED DRIVE PLUG ASSEMBLIES**

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(73) Assignee: **HUNTER DOUGLAS INC.**, Pearl River, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 32 days.

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(22) Filed: **Nov. 22, 2019**

(65) **Prior Publication Data**

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Related U.S. Application Data

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(51) **Int. Cl.**
E06B 9/42 (2006.01)

(52) **U.S. Cl.**
CPC ***E06B 9/42*** (2013.01)

(58) **Field of Classification Search**
CPC E06B 9/60; E06B 9/62; E06B 9/68; E06B 9/80; E06B 9/82; E06B 2009/583; E06B 2009/785; E06B 2009/807; E06B 9/42
See application file for complete search history.

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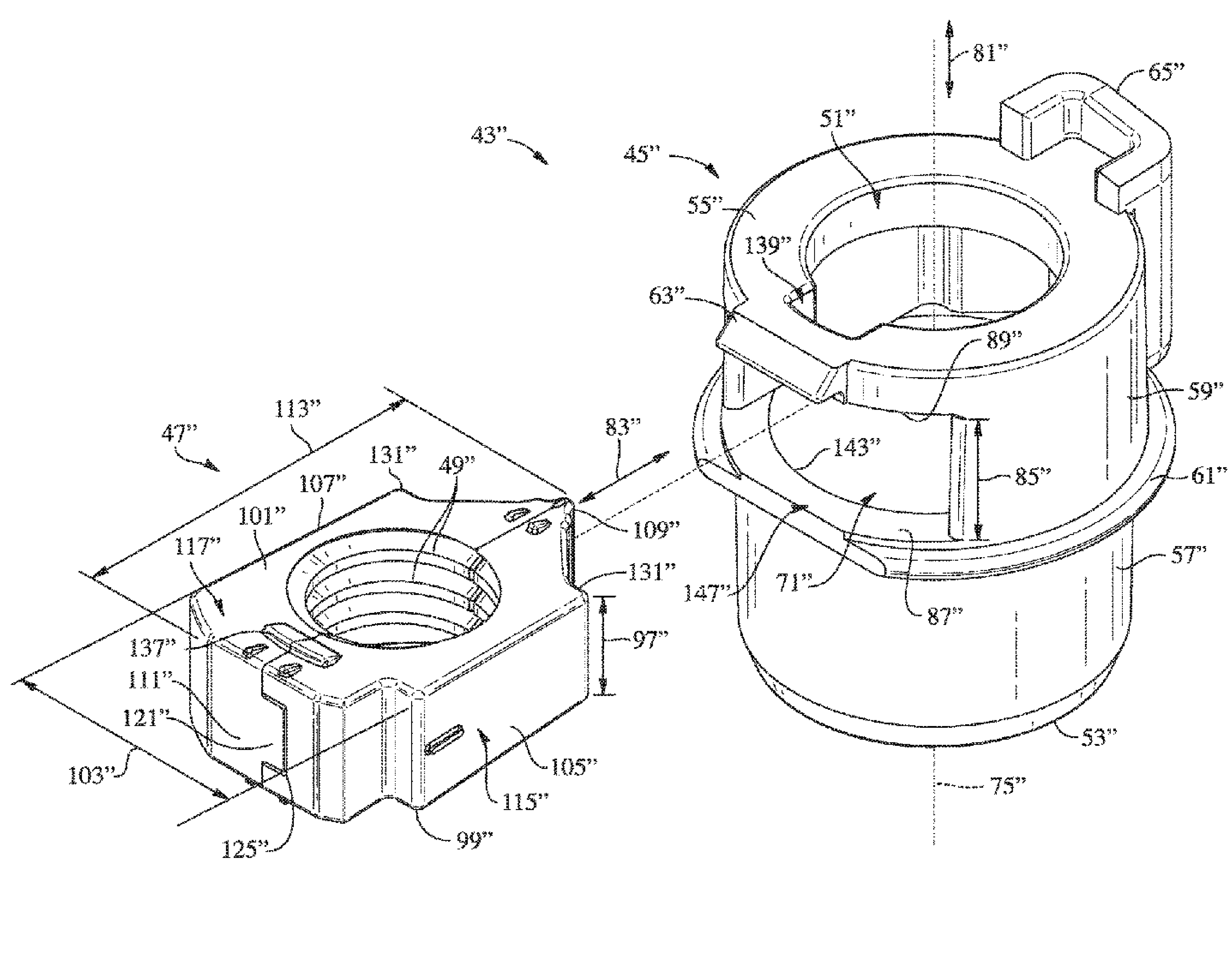
Primary Examiner — Beth A Stephan
(74) *Attorney, Agent, or Firm* — Dority & Manning, P.A.

(57) **ABSTRACT**

In one aspect, a power assist module for covering for an architectural structure may include a spring and a spring shaft extending through the spring. Additionally, the power assist module may include a threaded shaft member coupled to the spring shaft and a drive plug assembly coupled to the threaded shaft member for rotation relative thereto. The drive plug assembly includes a follower member and a separate threaded insert configured to be received within the follower member. The threaded insert is configured to threadably engage the threaded shaft member to allow the follower member to be rotationally coupled to the threaded shaft member in a manner that allows the follower member to move axially along the threaded shaft member as the follower member is rotated relative to the threaded shaft member.

20 Claims, 53 Drawing Sheets



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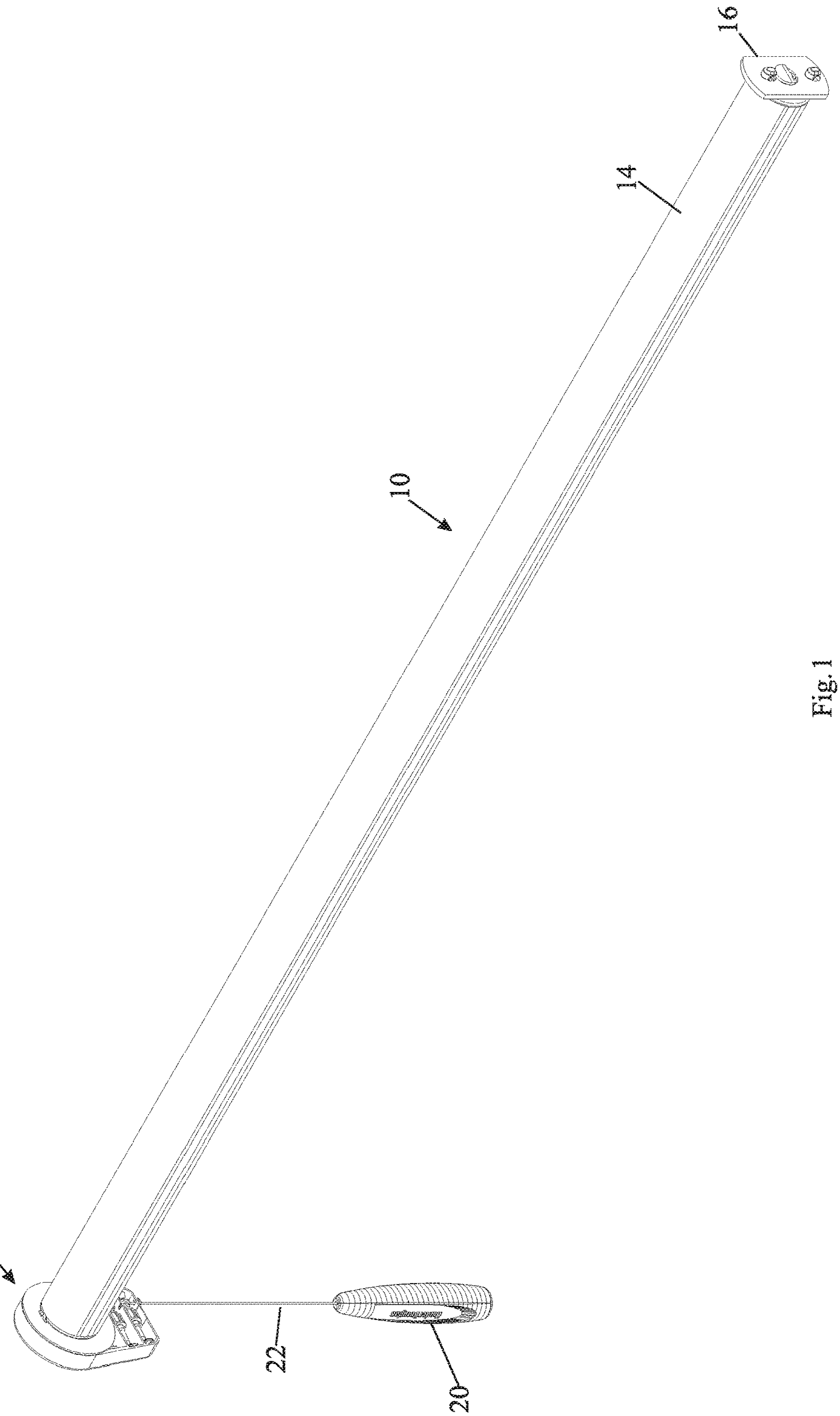

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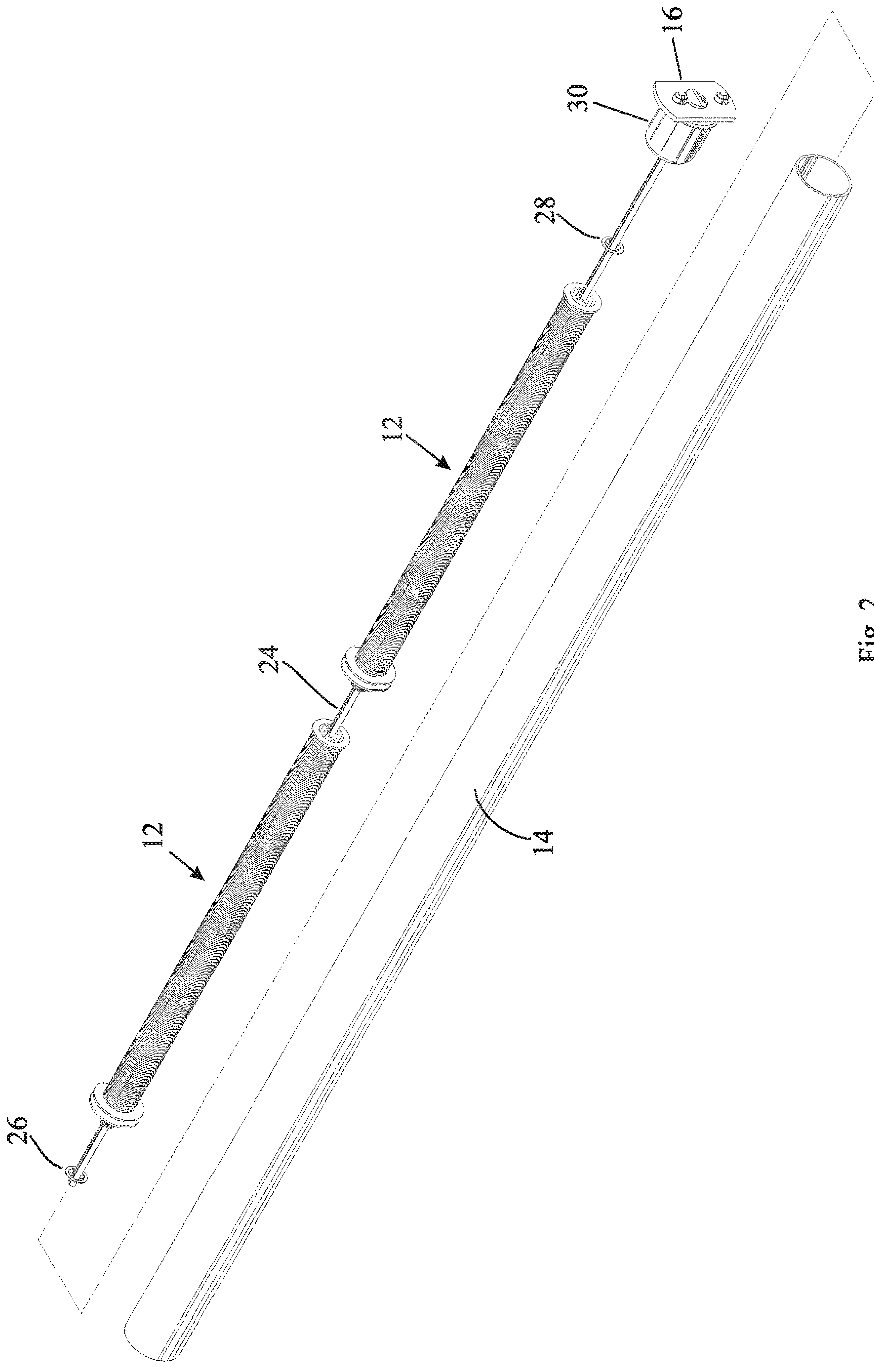

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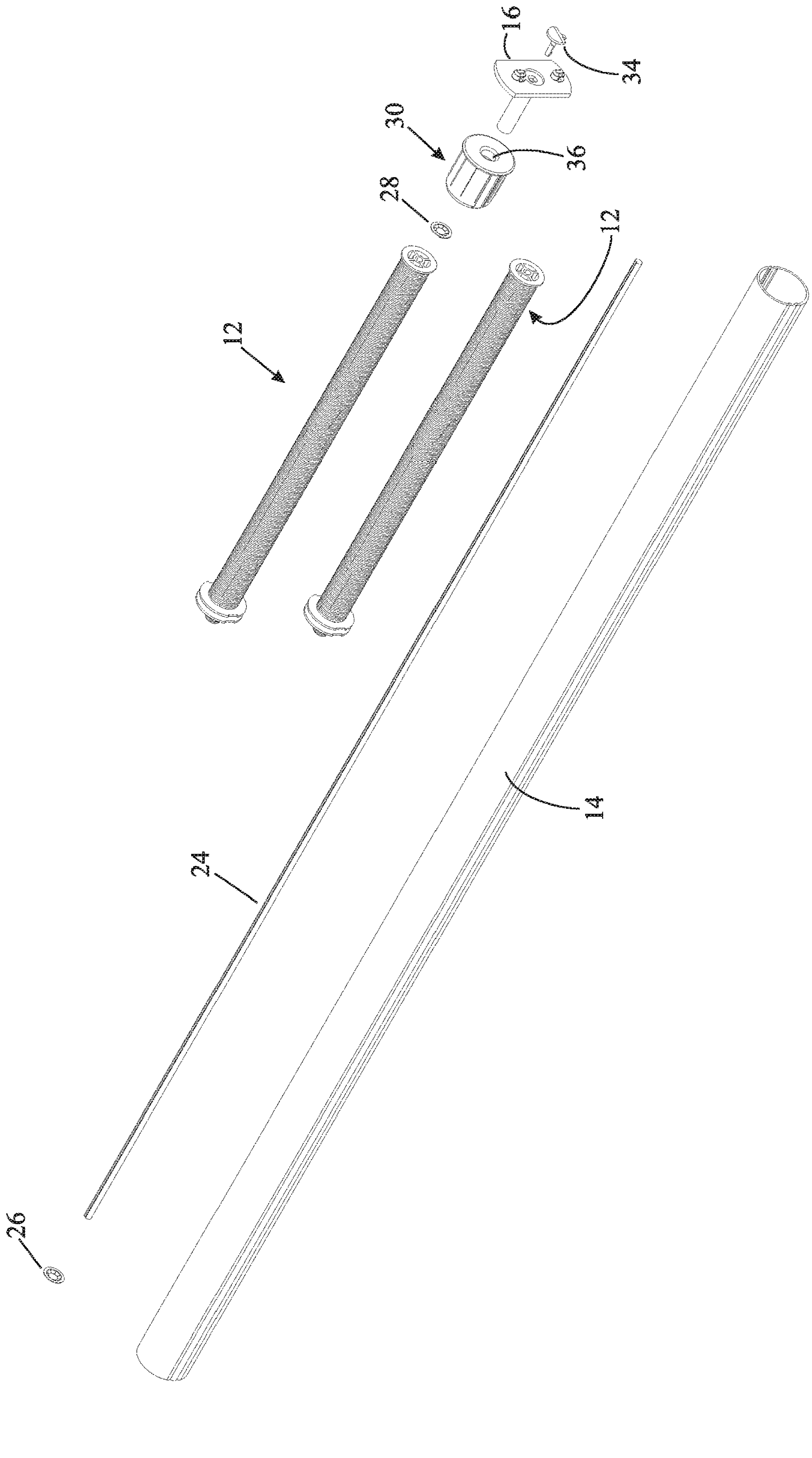

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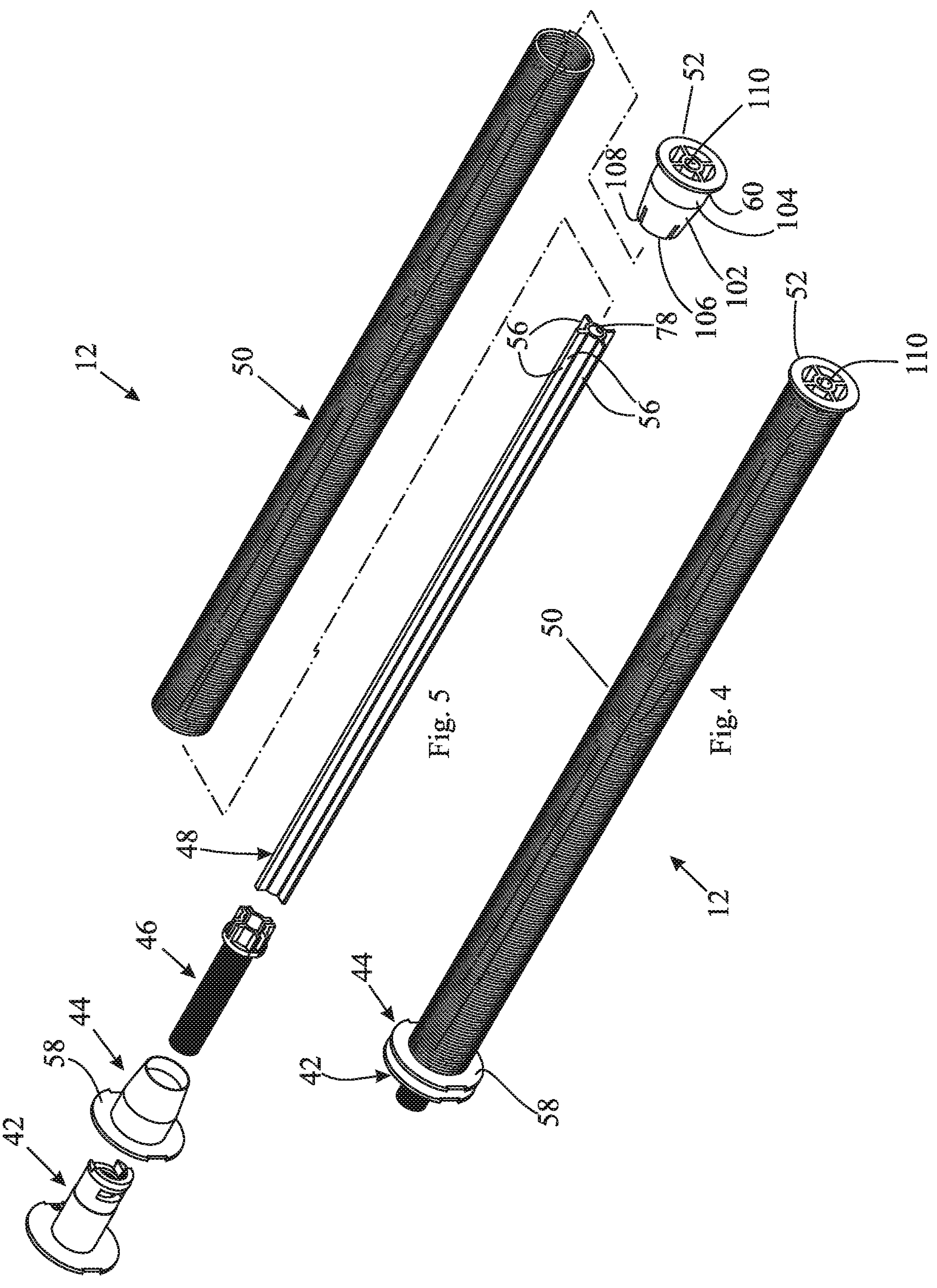
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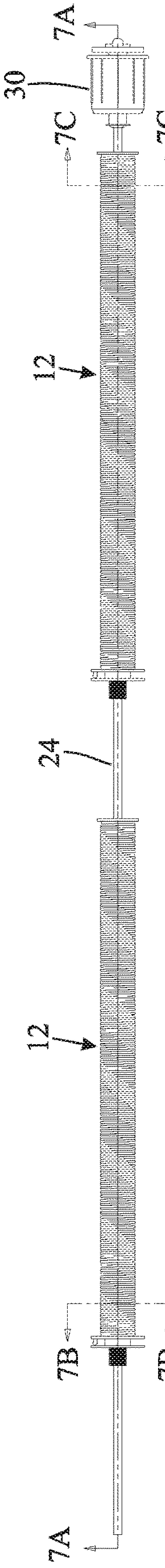
Fig. 5

Fig. 4



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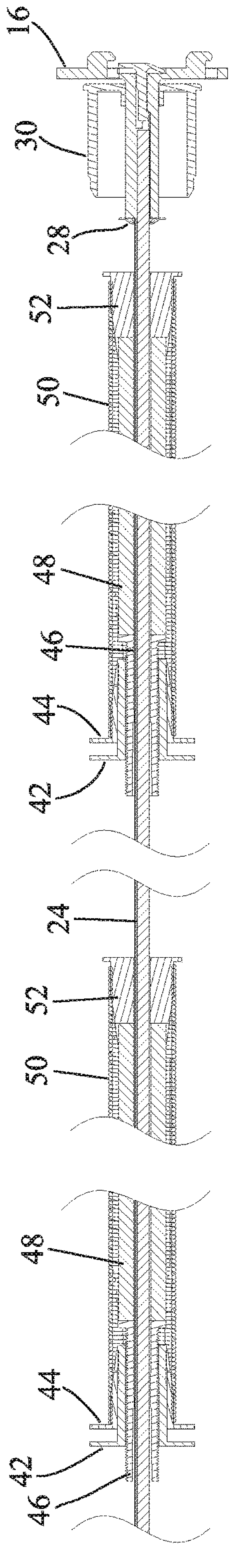

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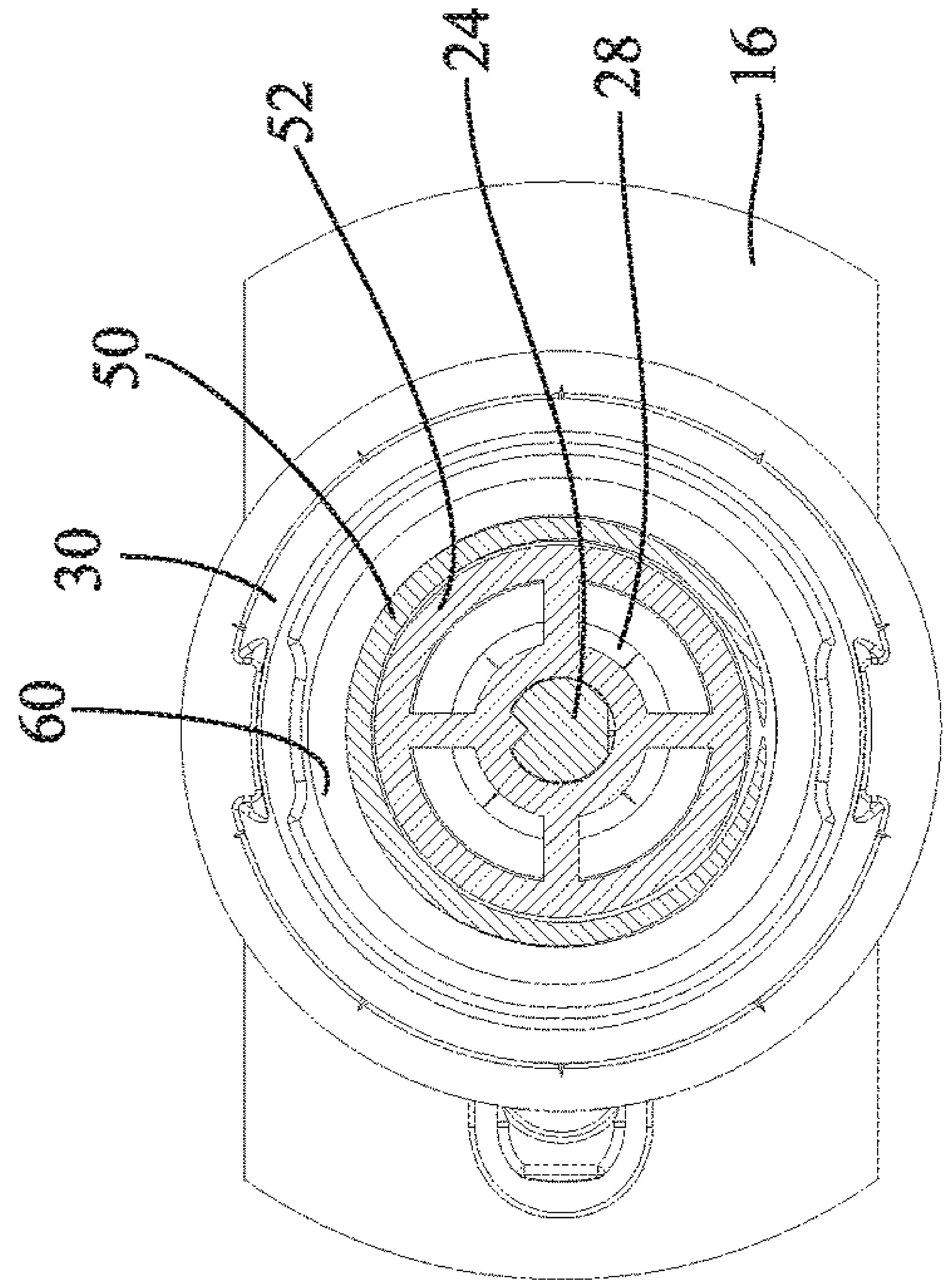

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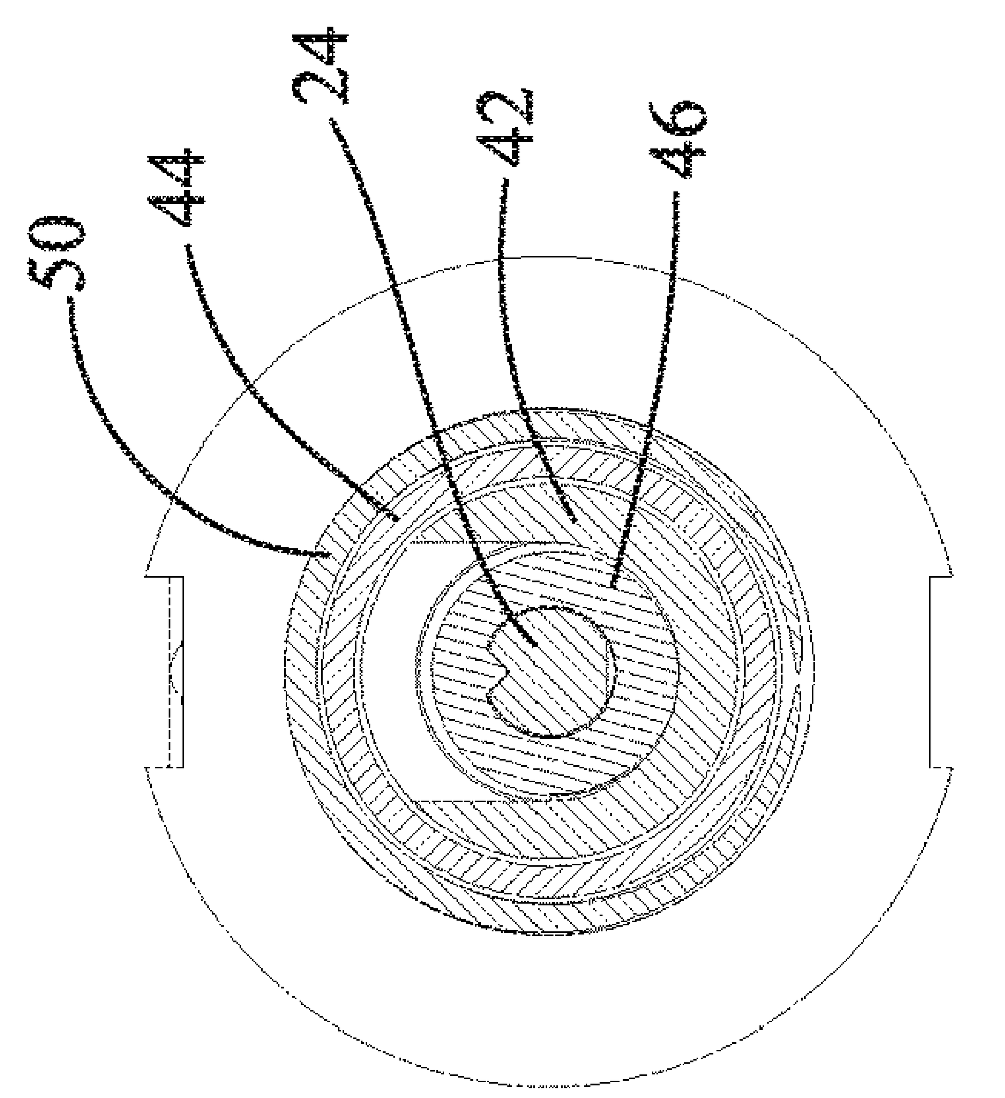

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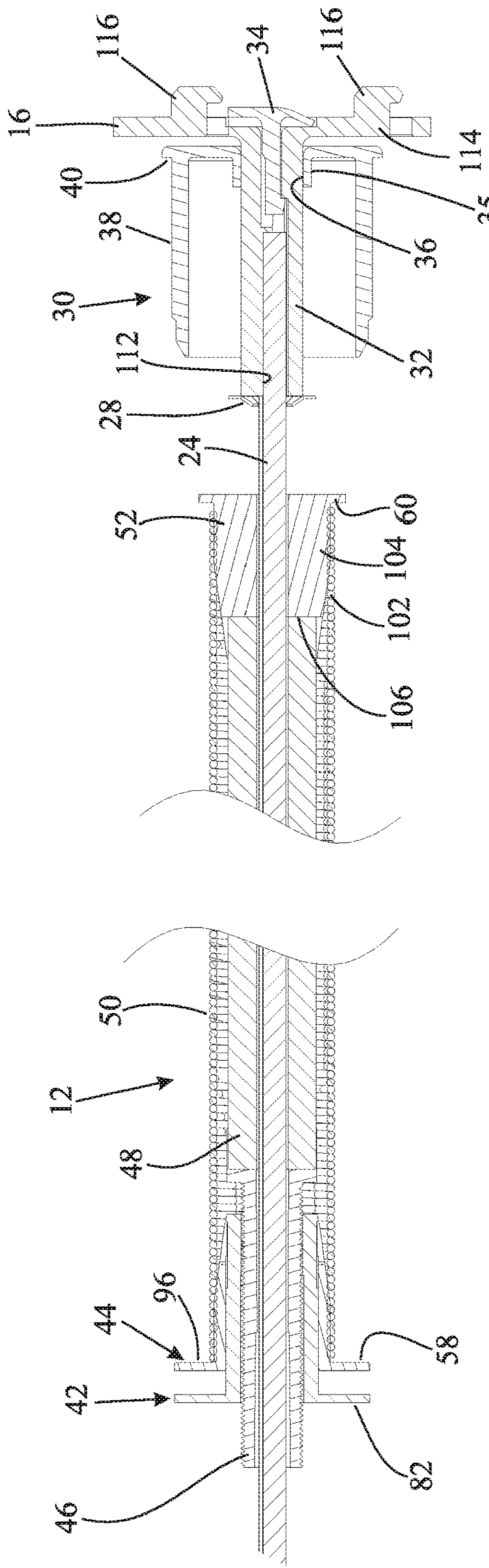
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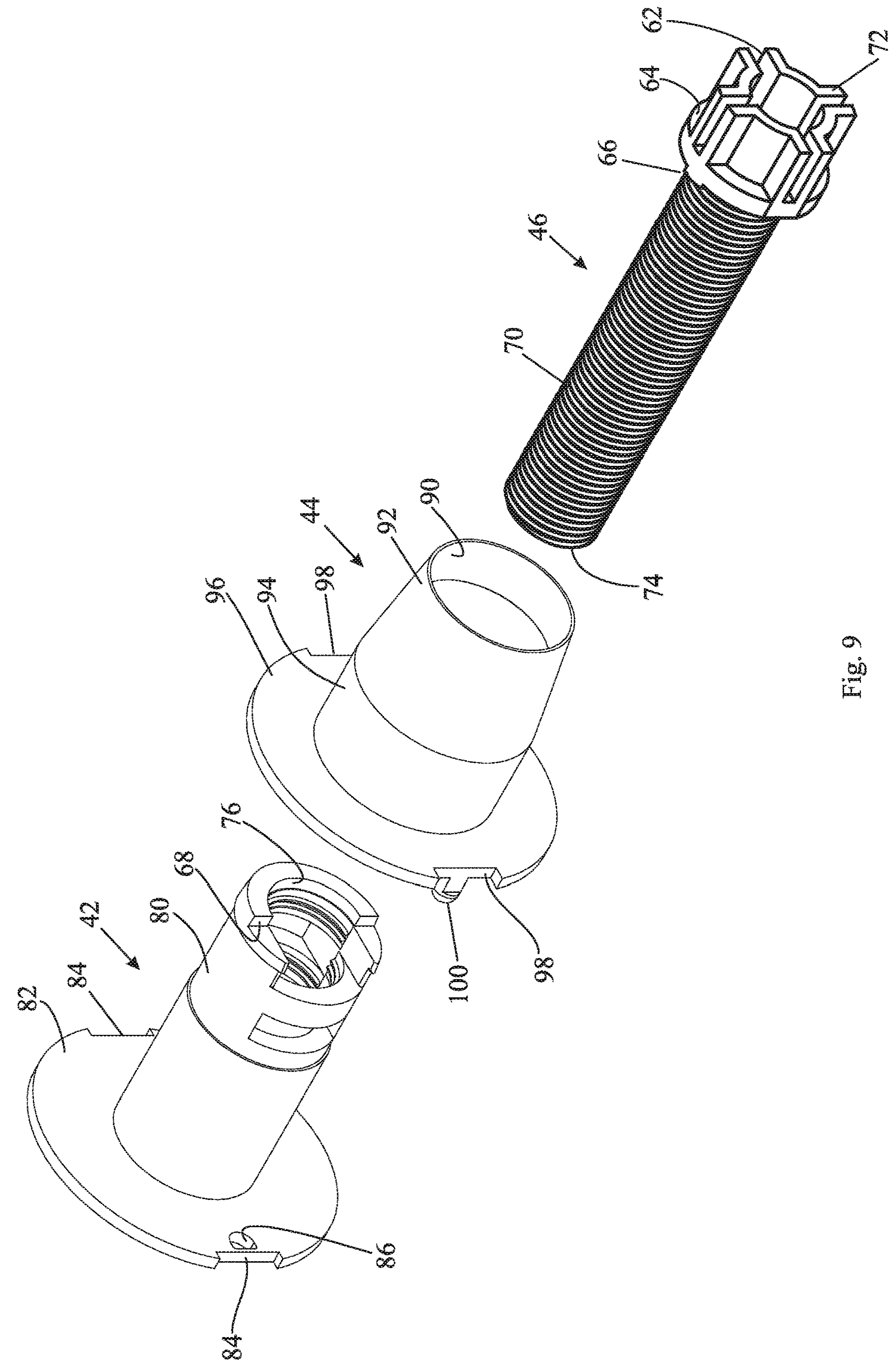
Fig. 8



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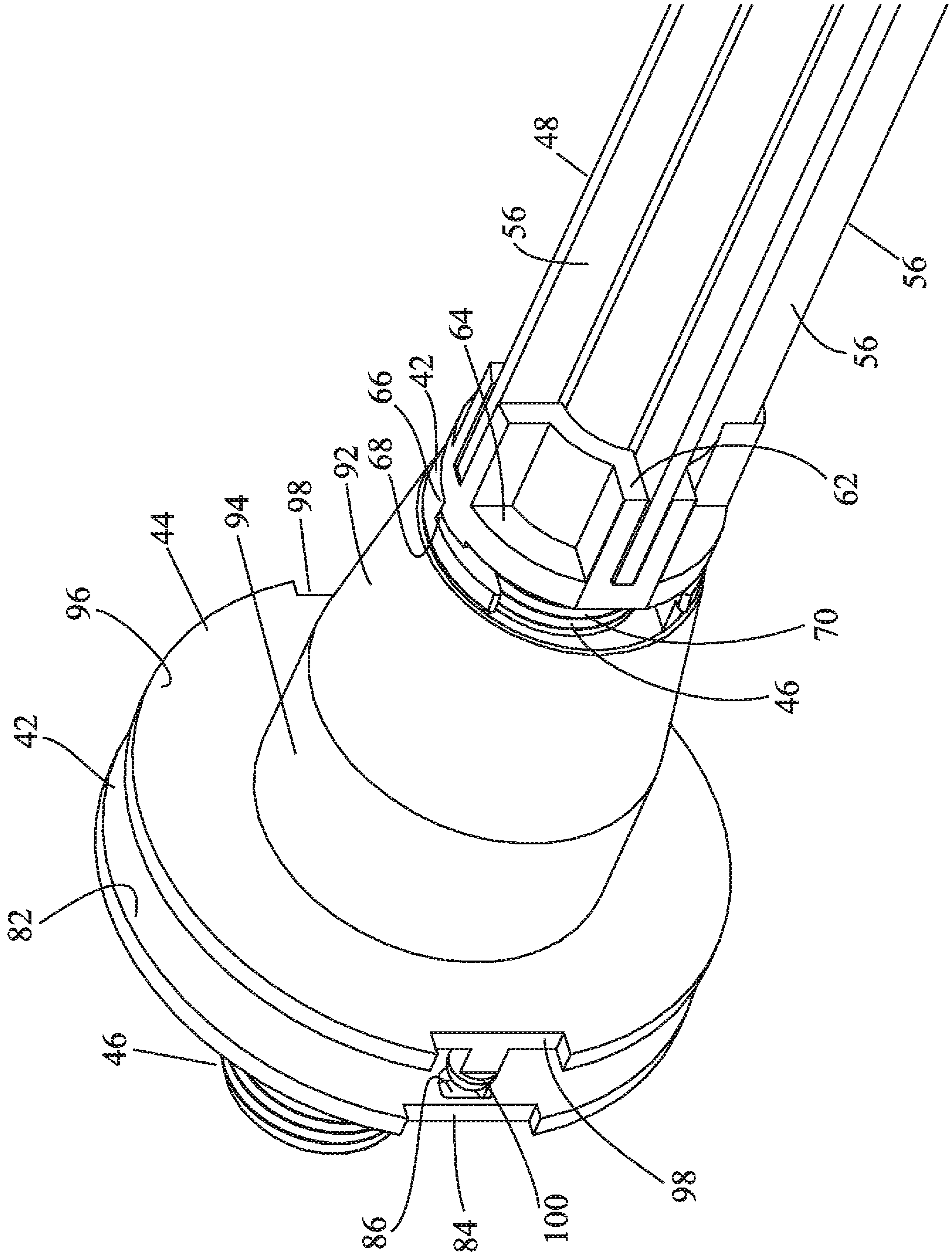

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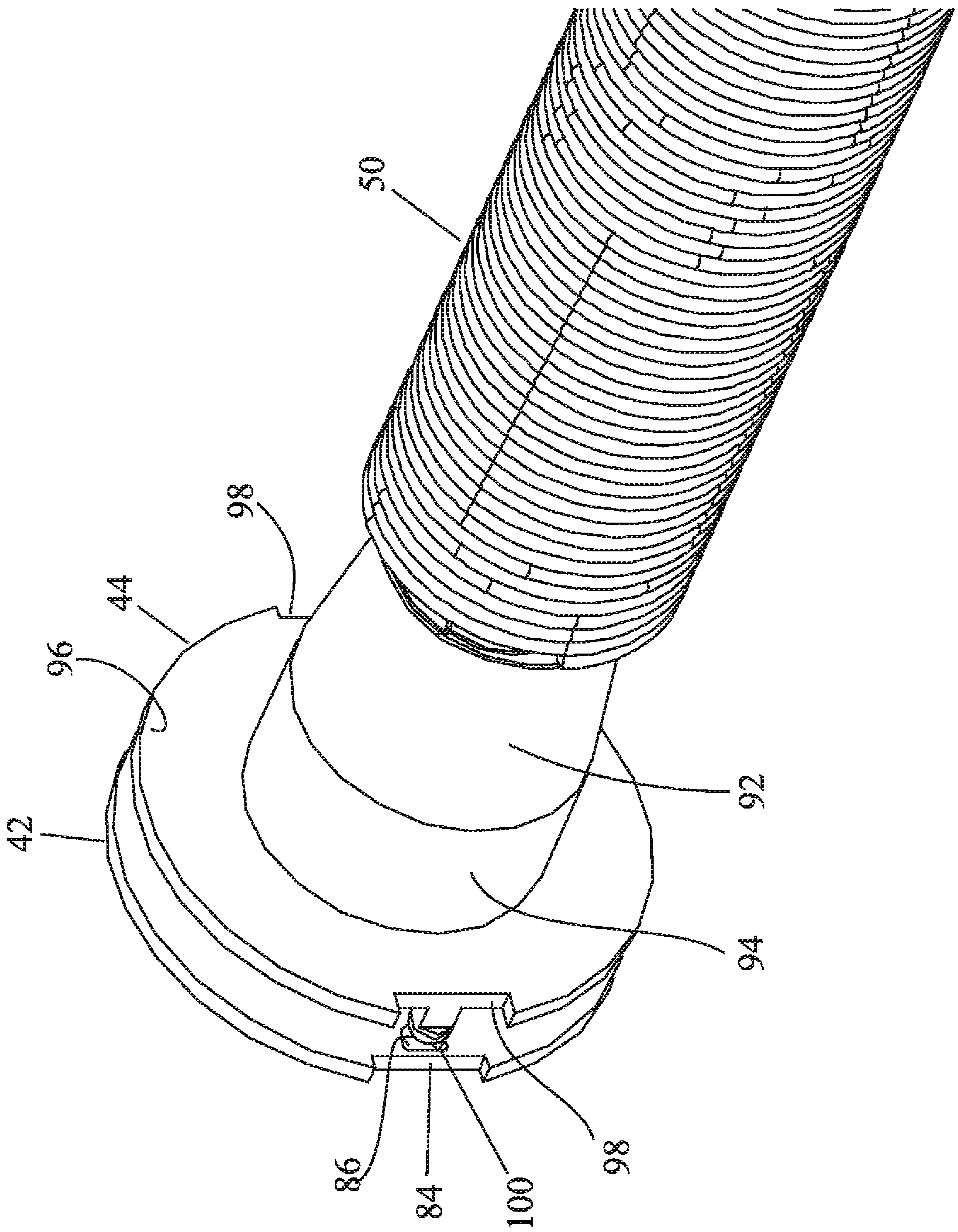

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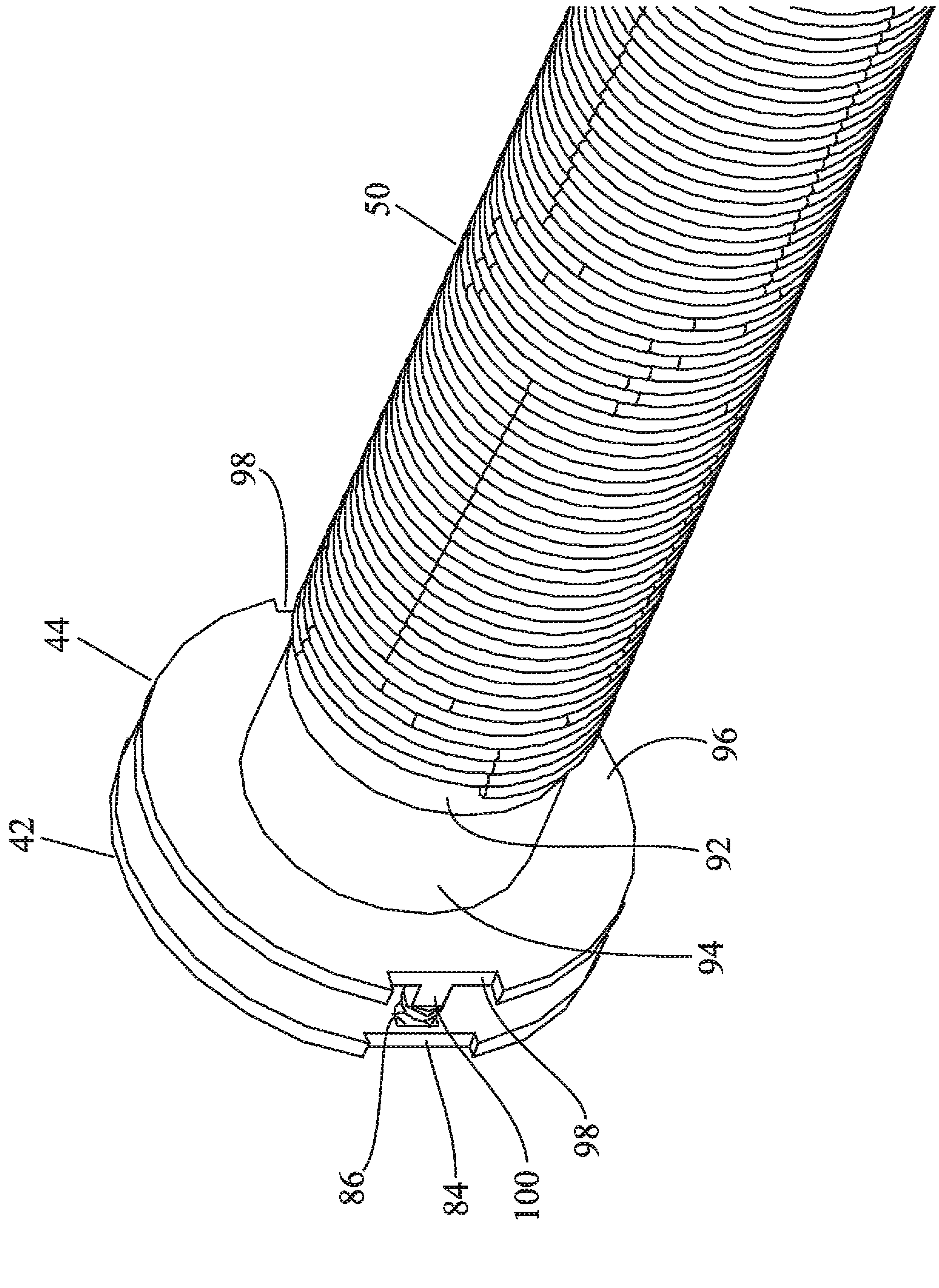

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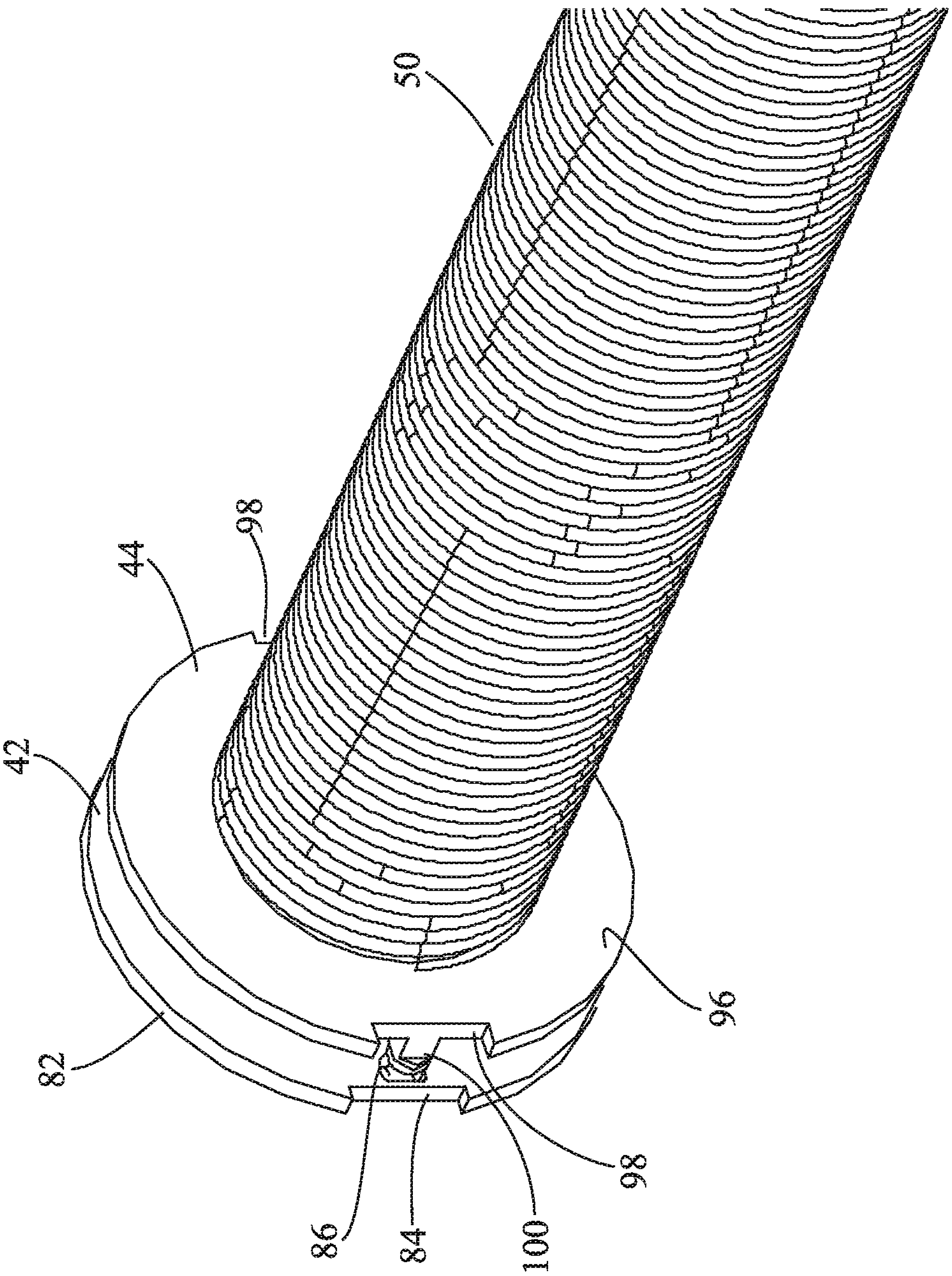

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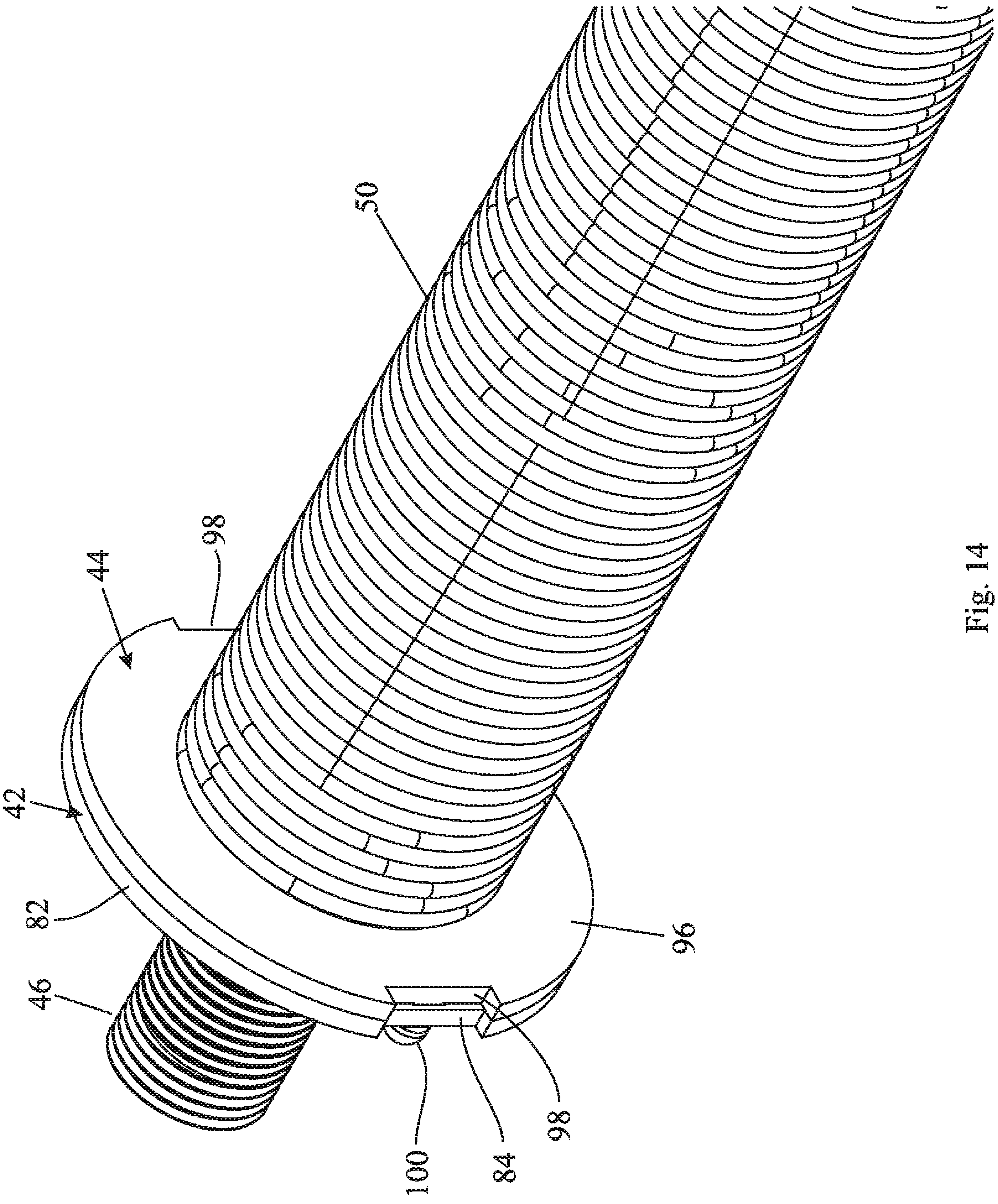

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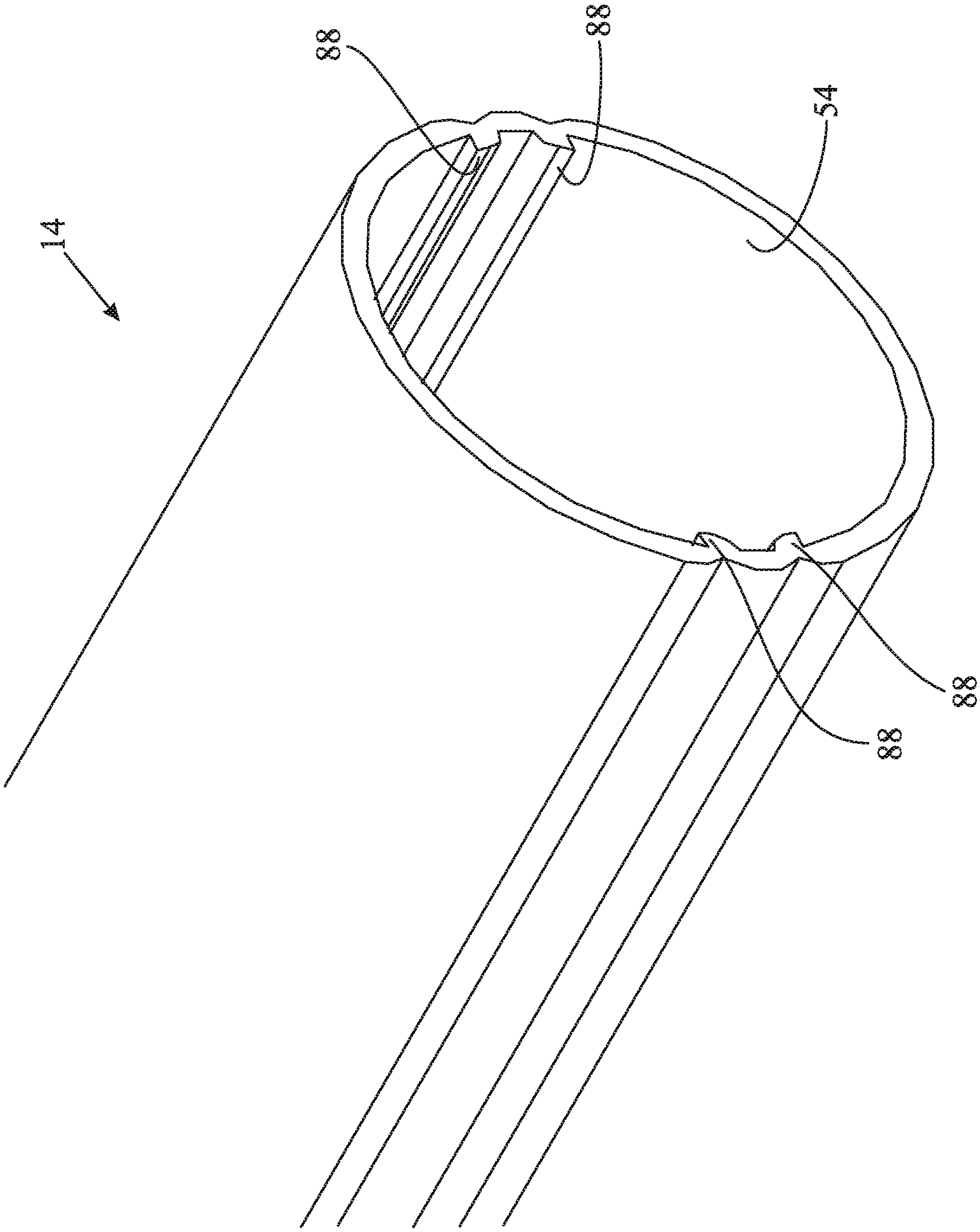

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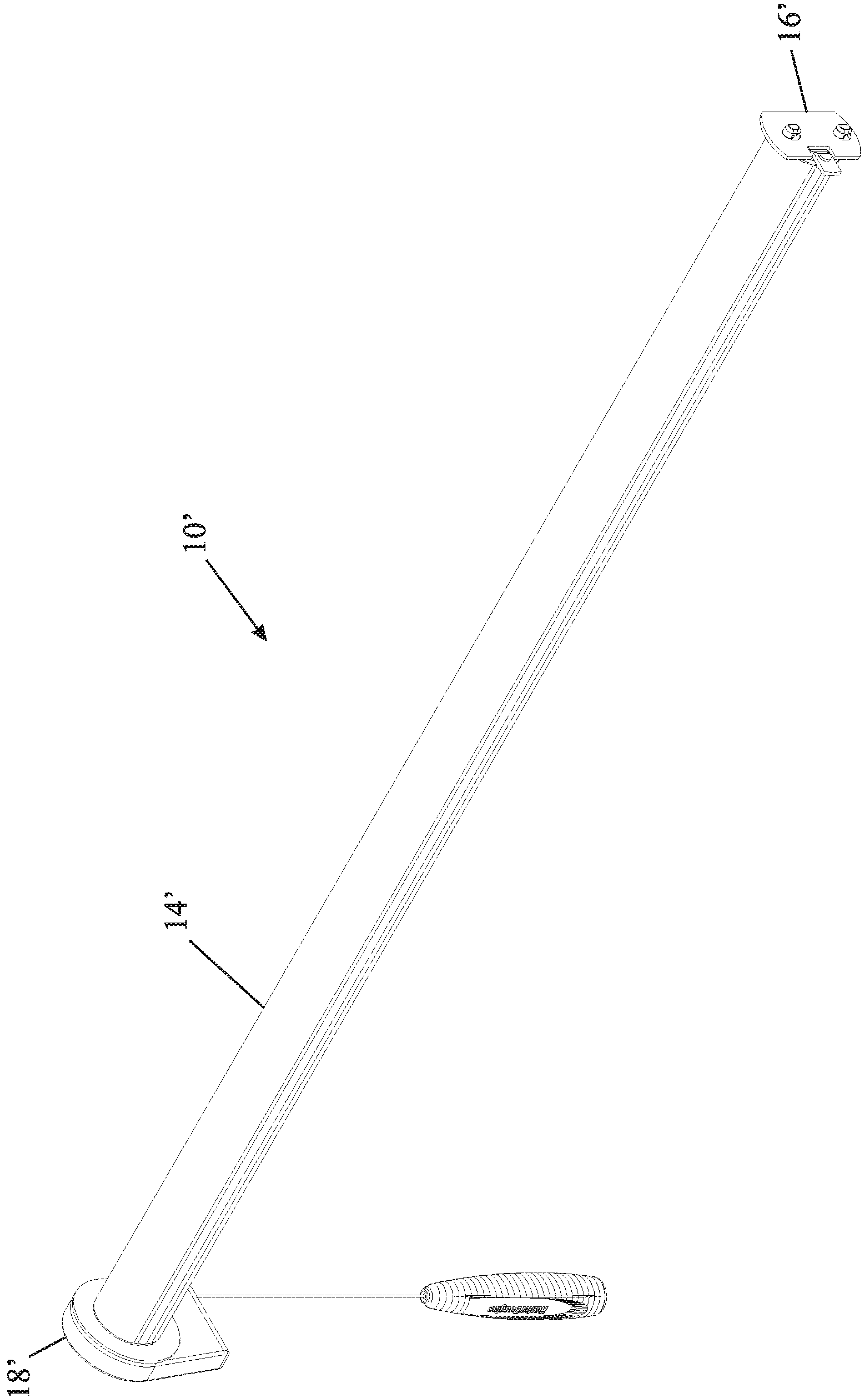

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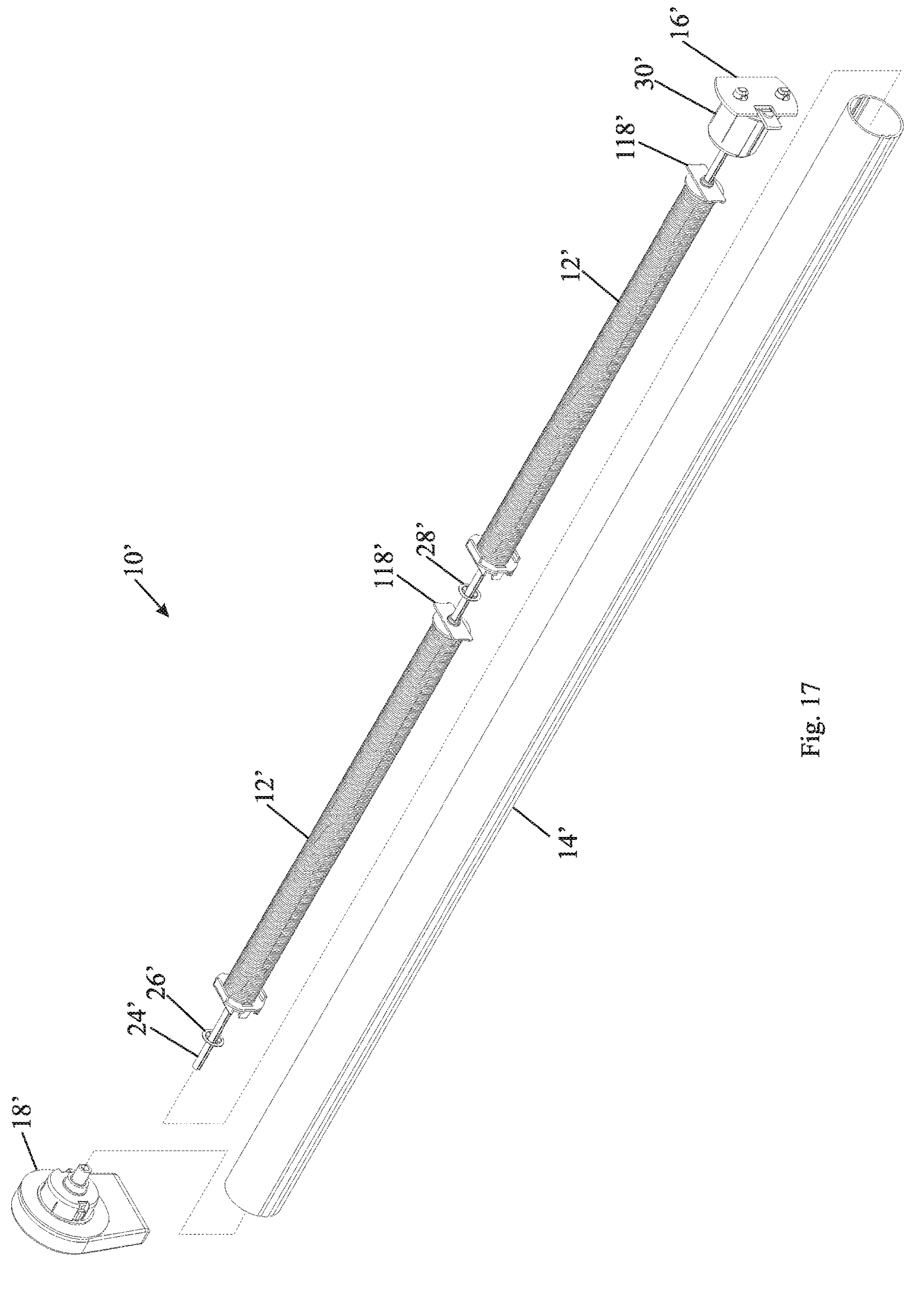

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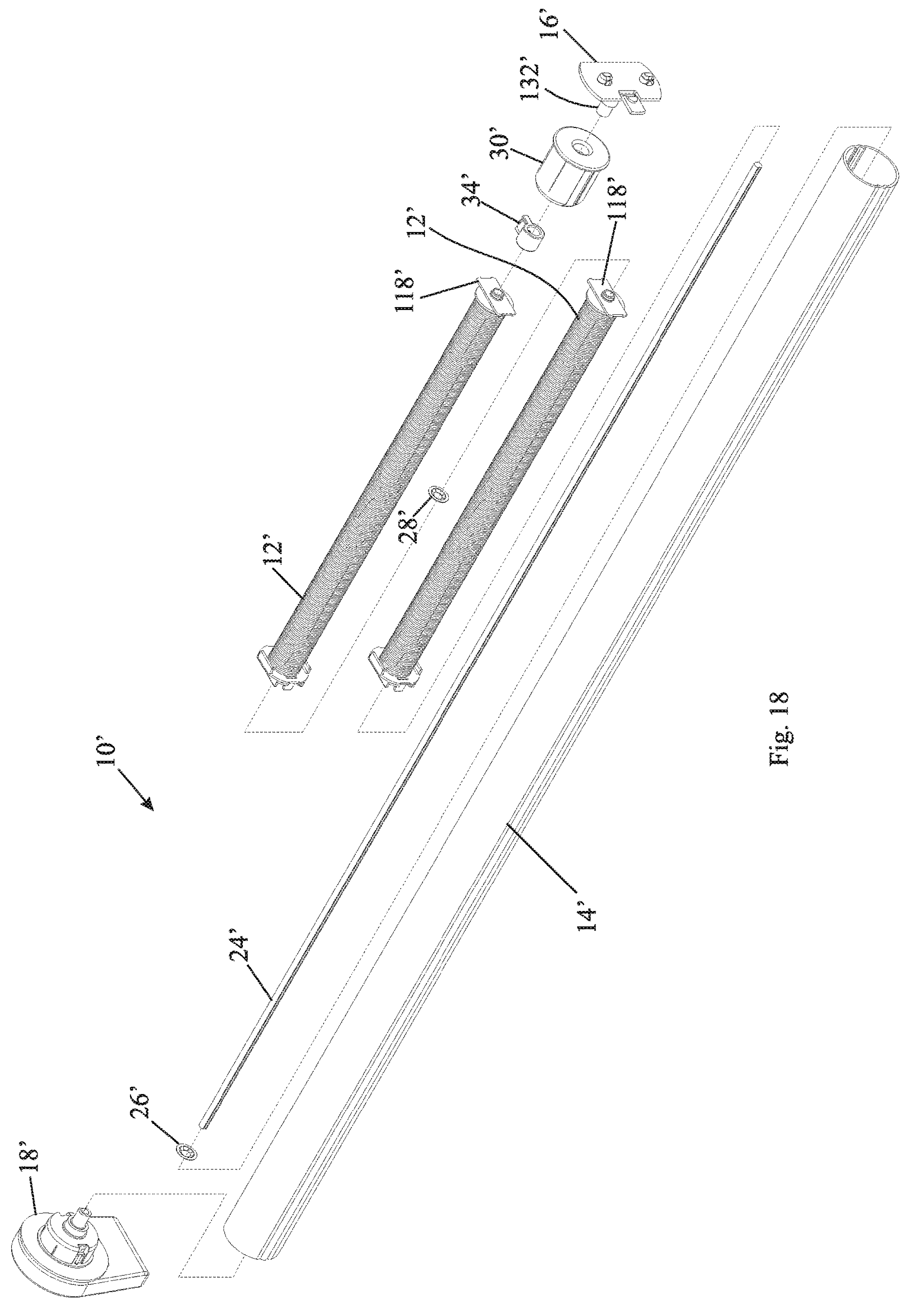

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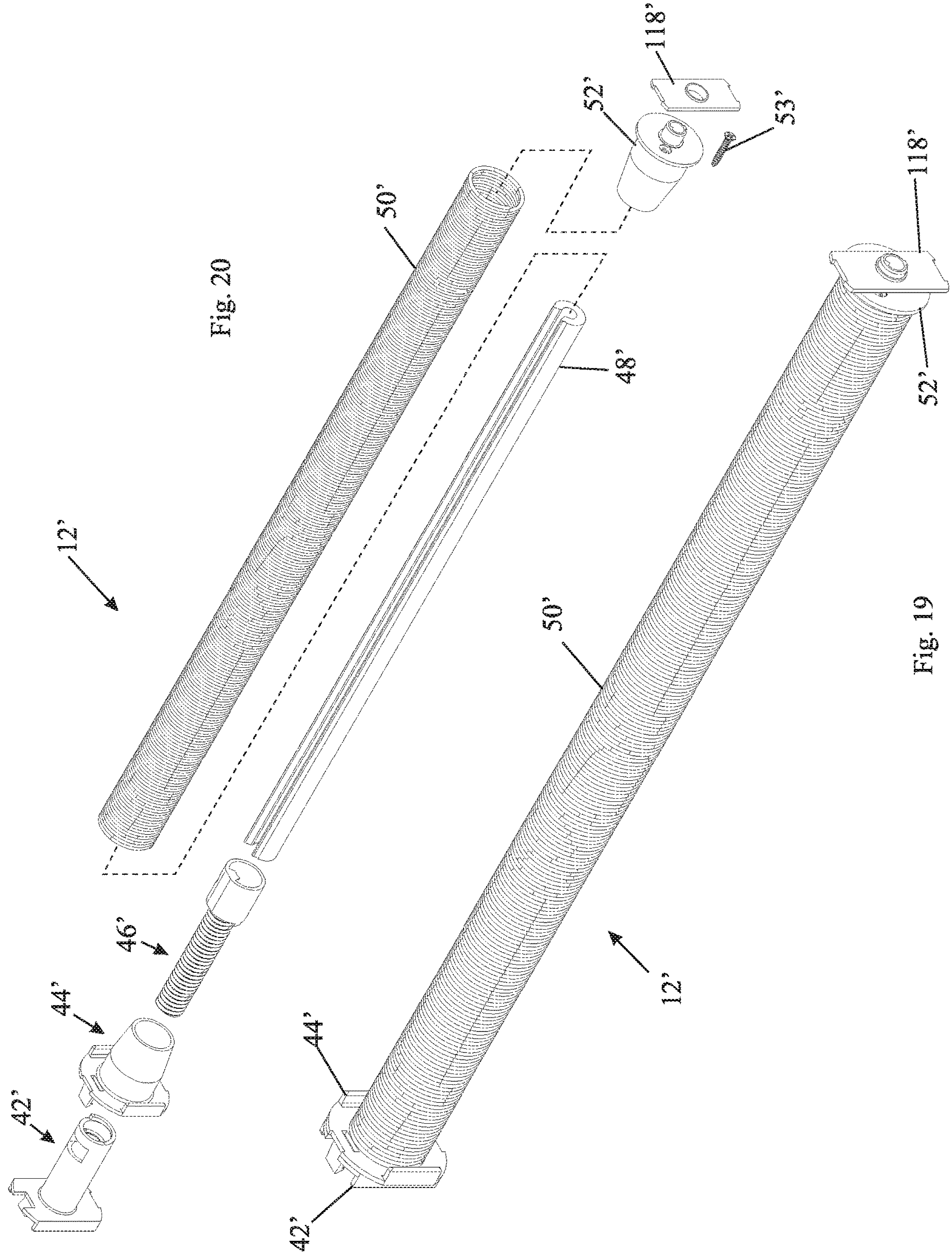

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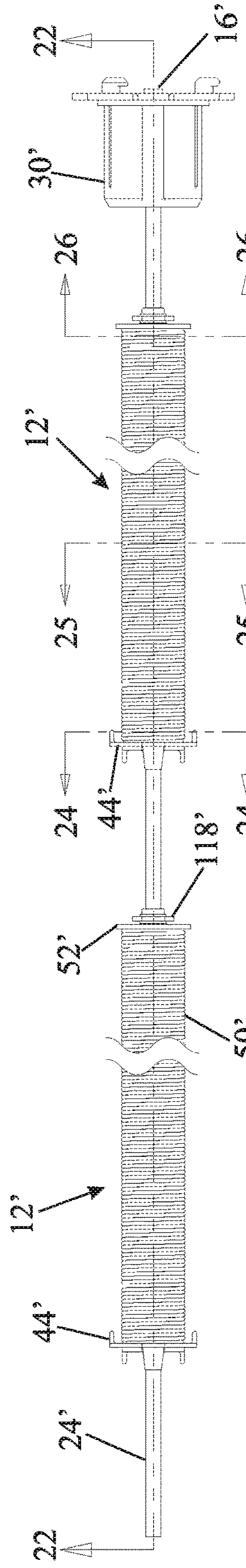

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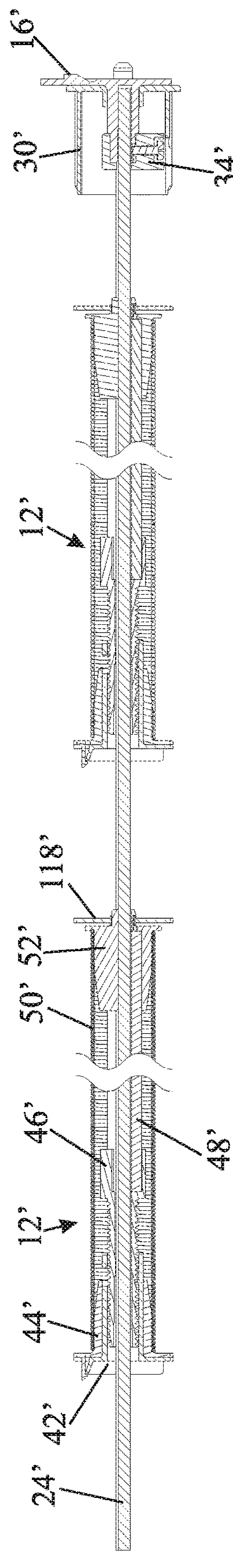

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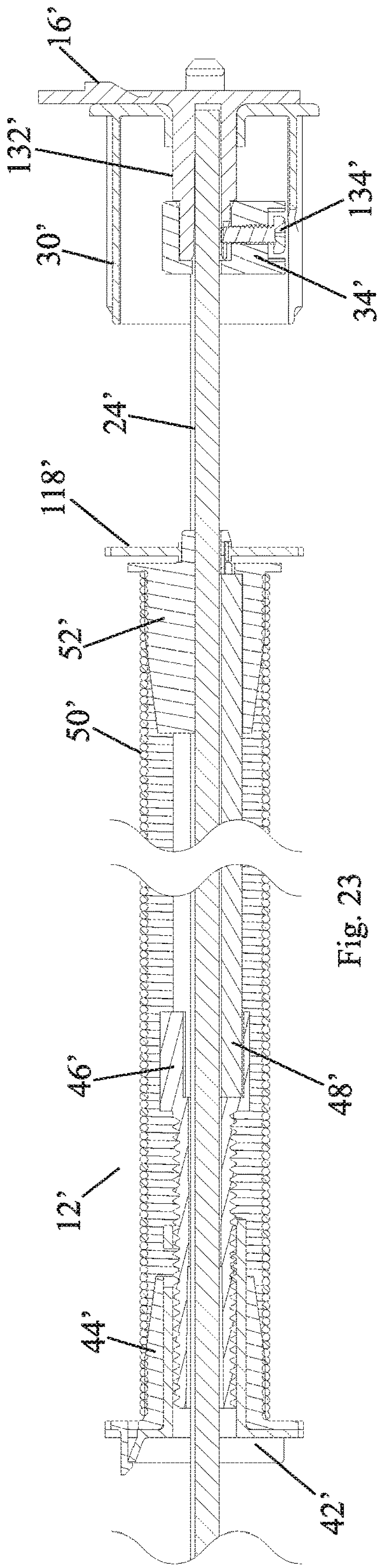

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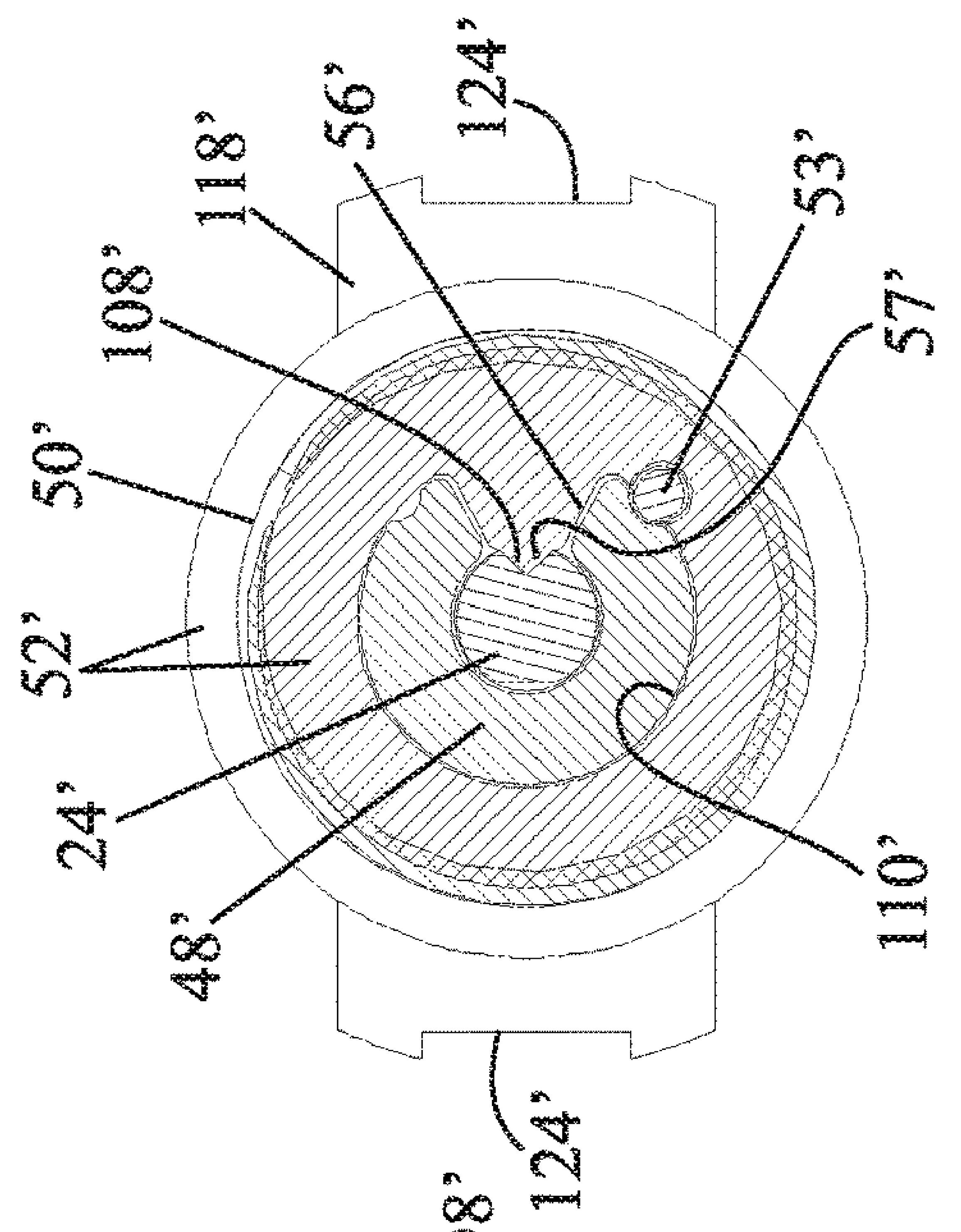

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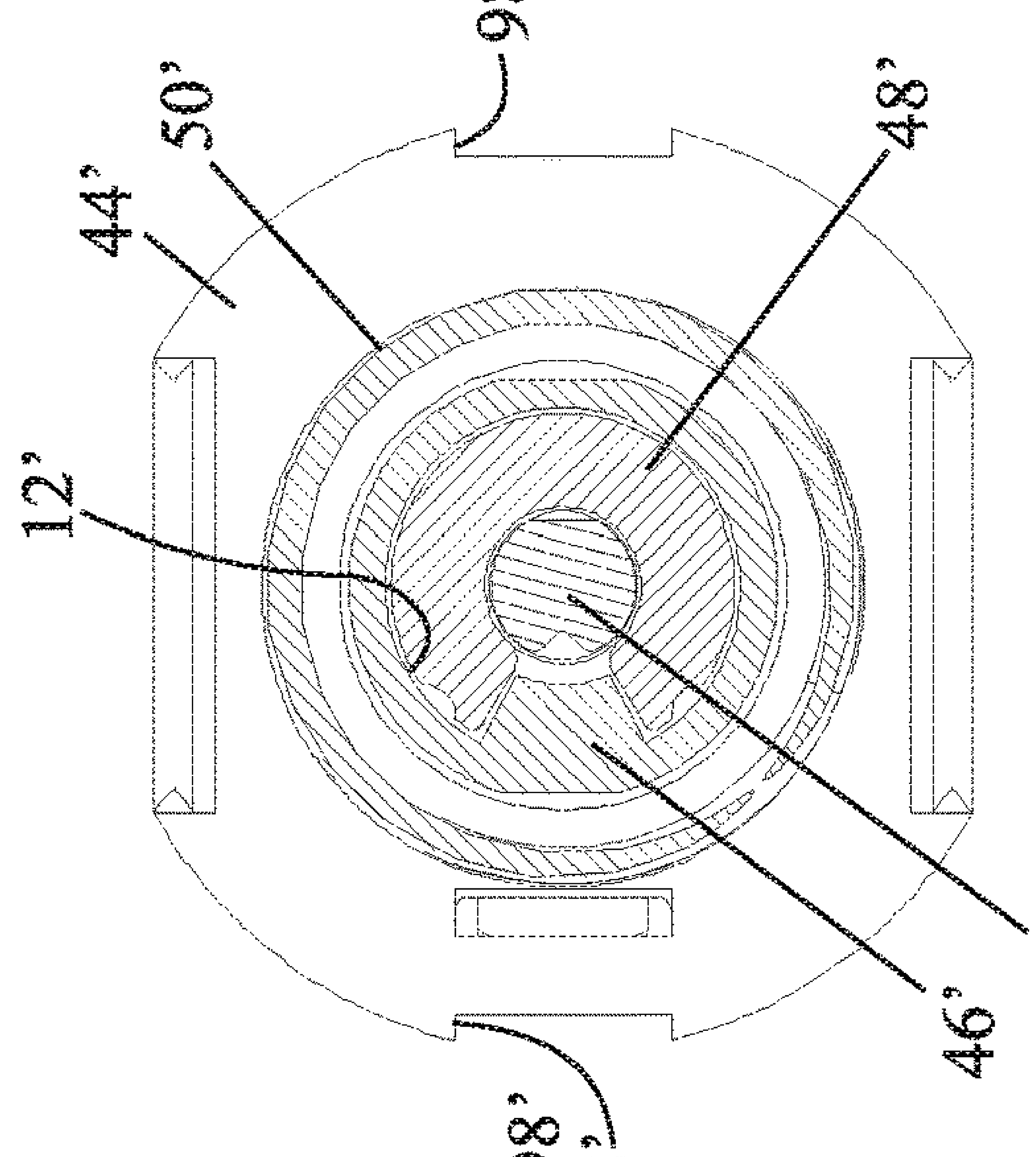

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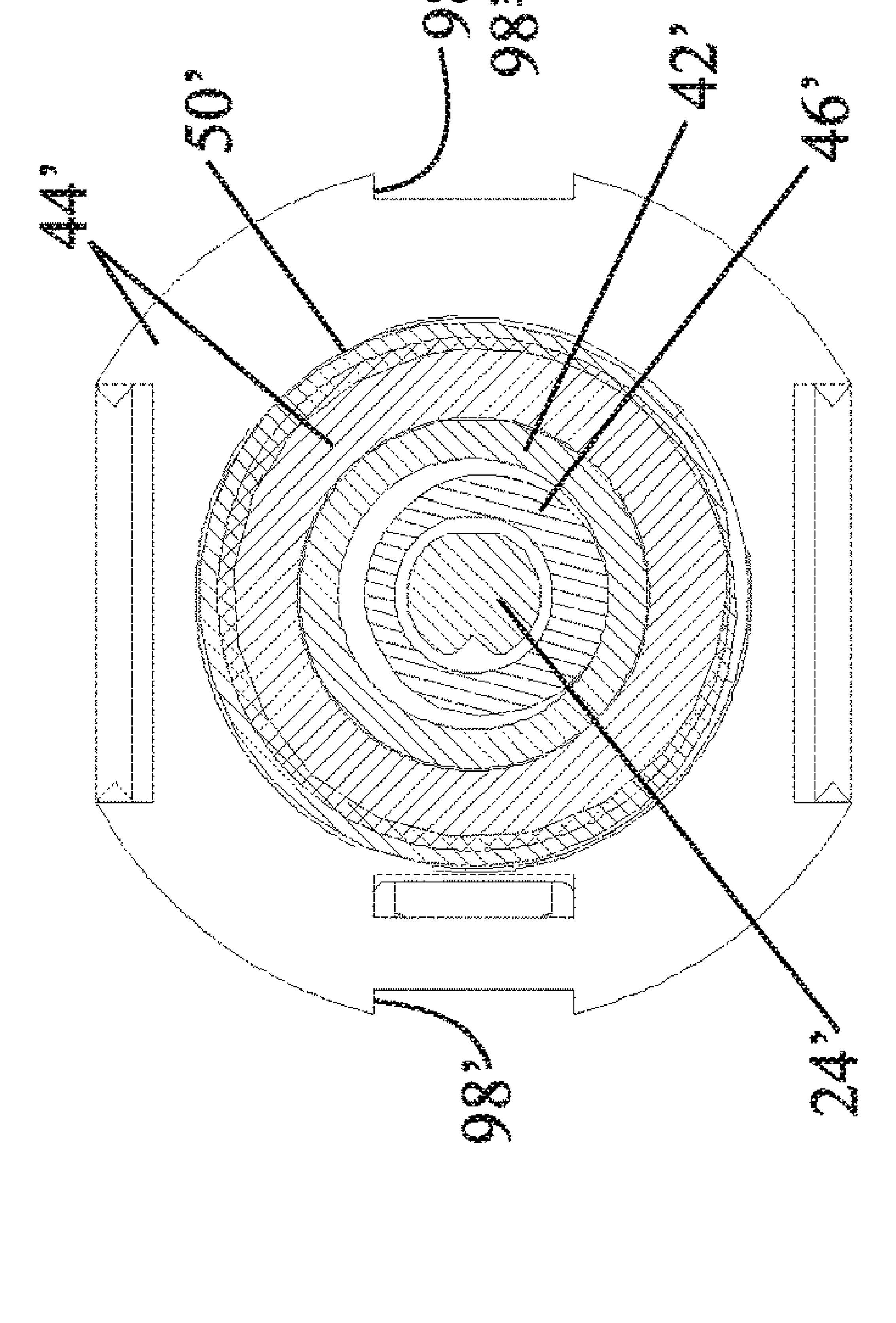

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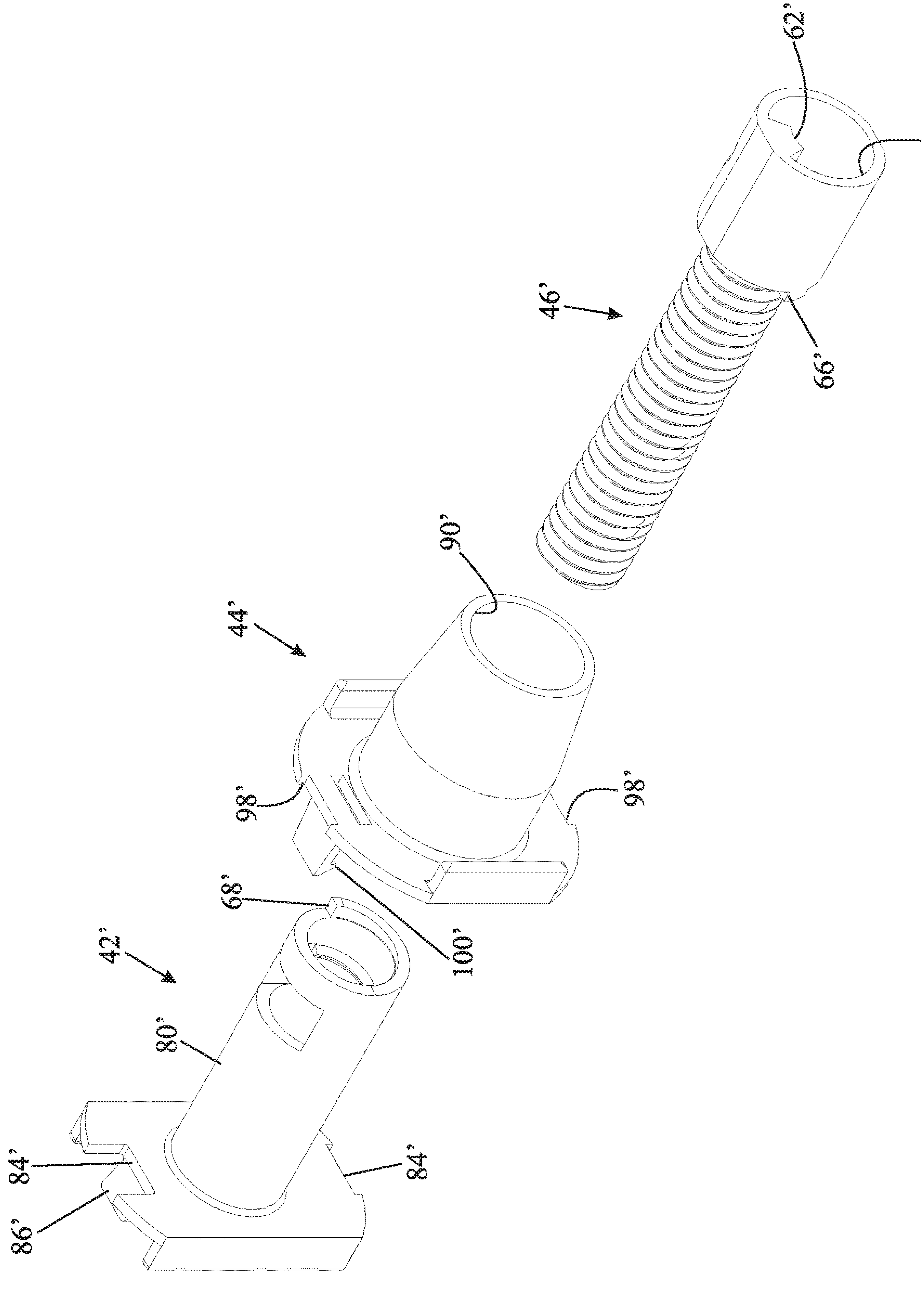

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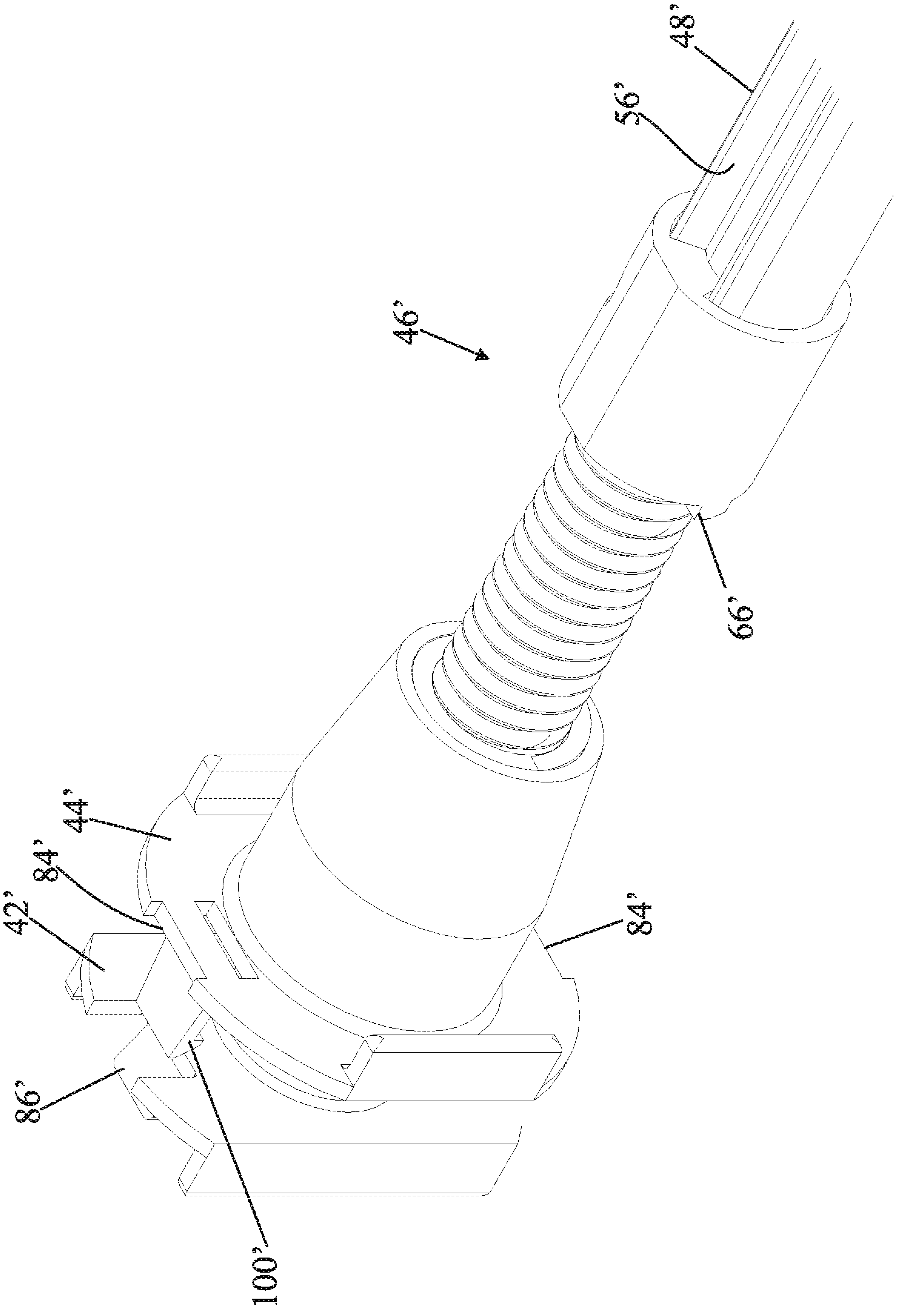

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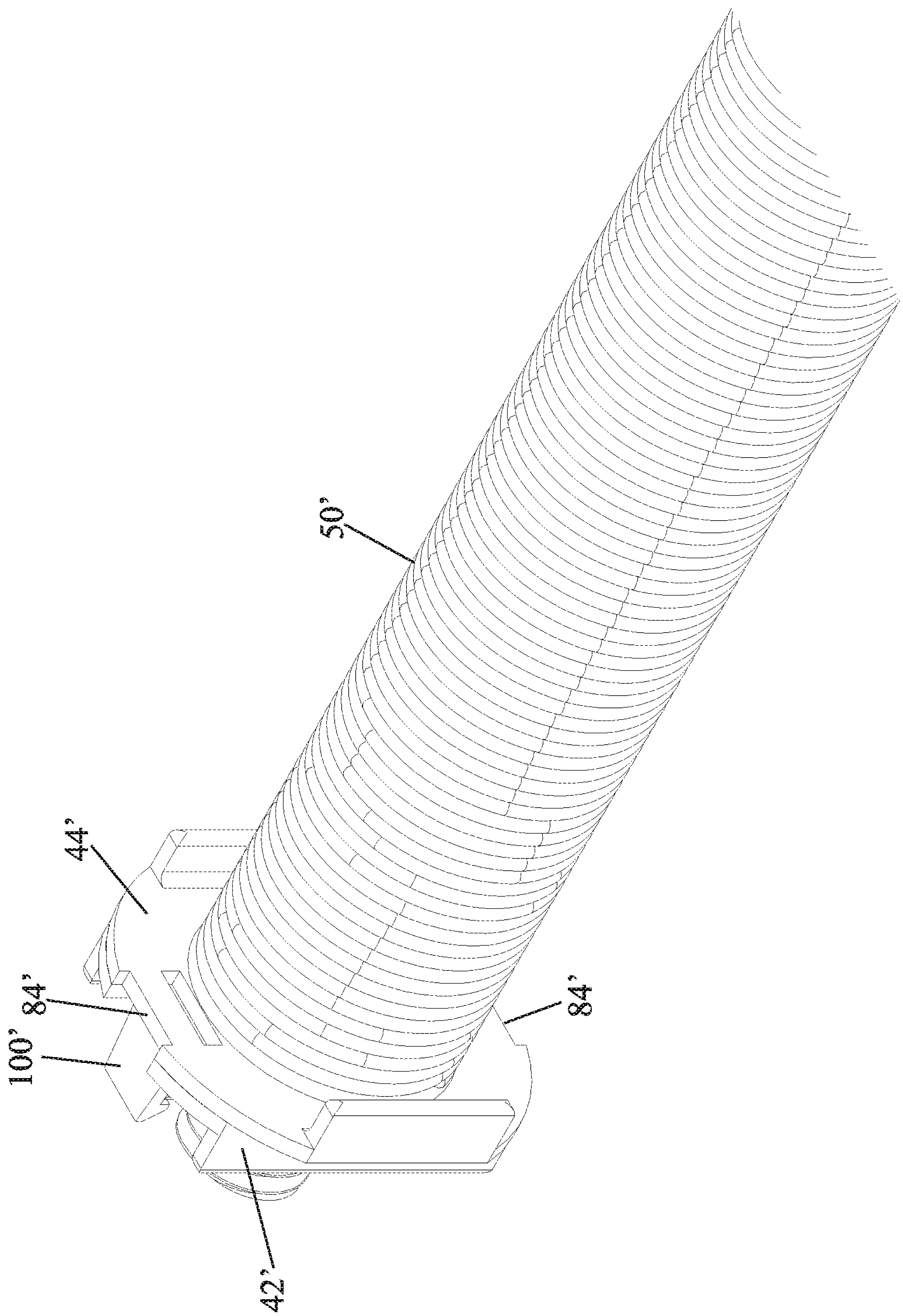

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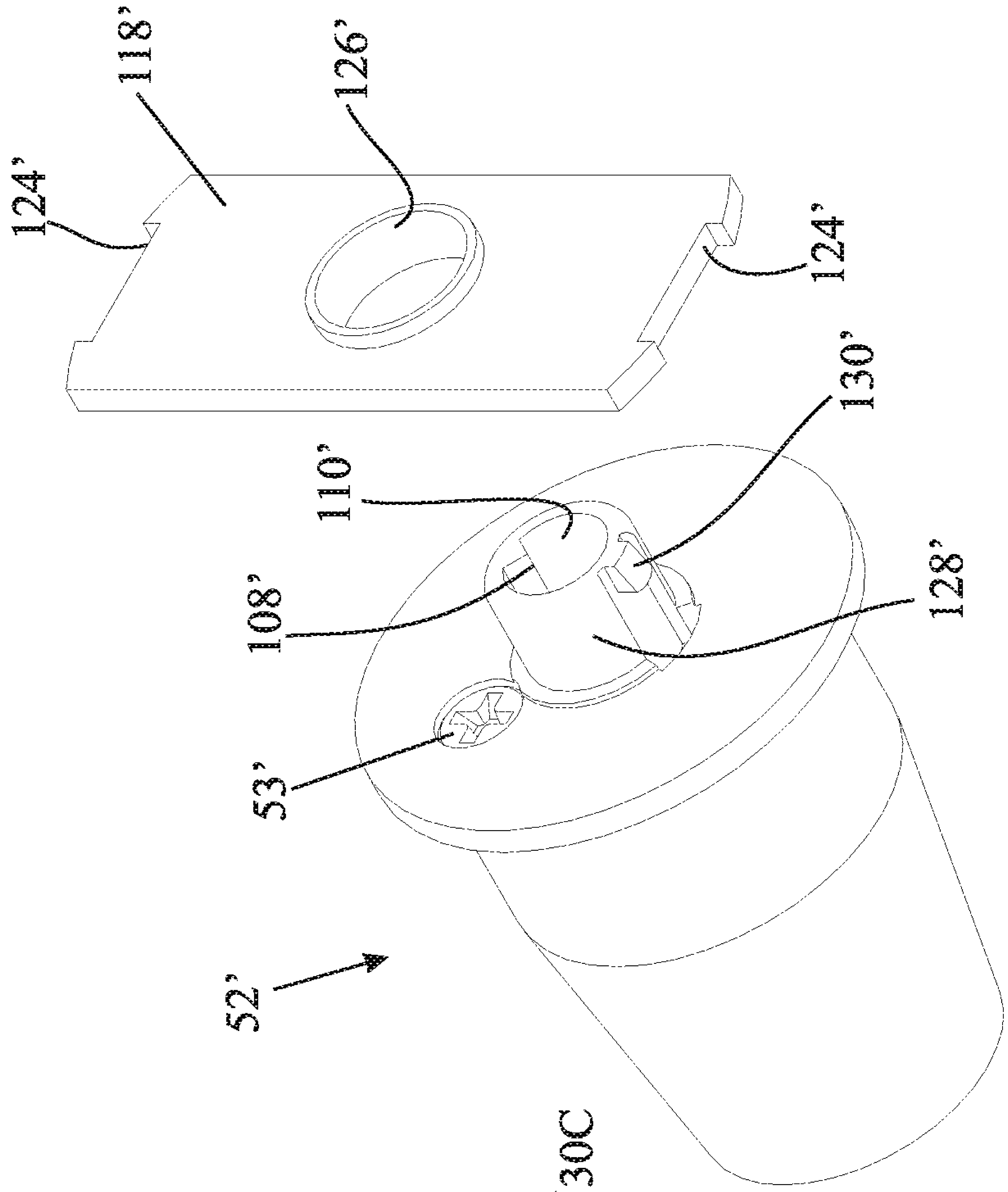

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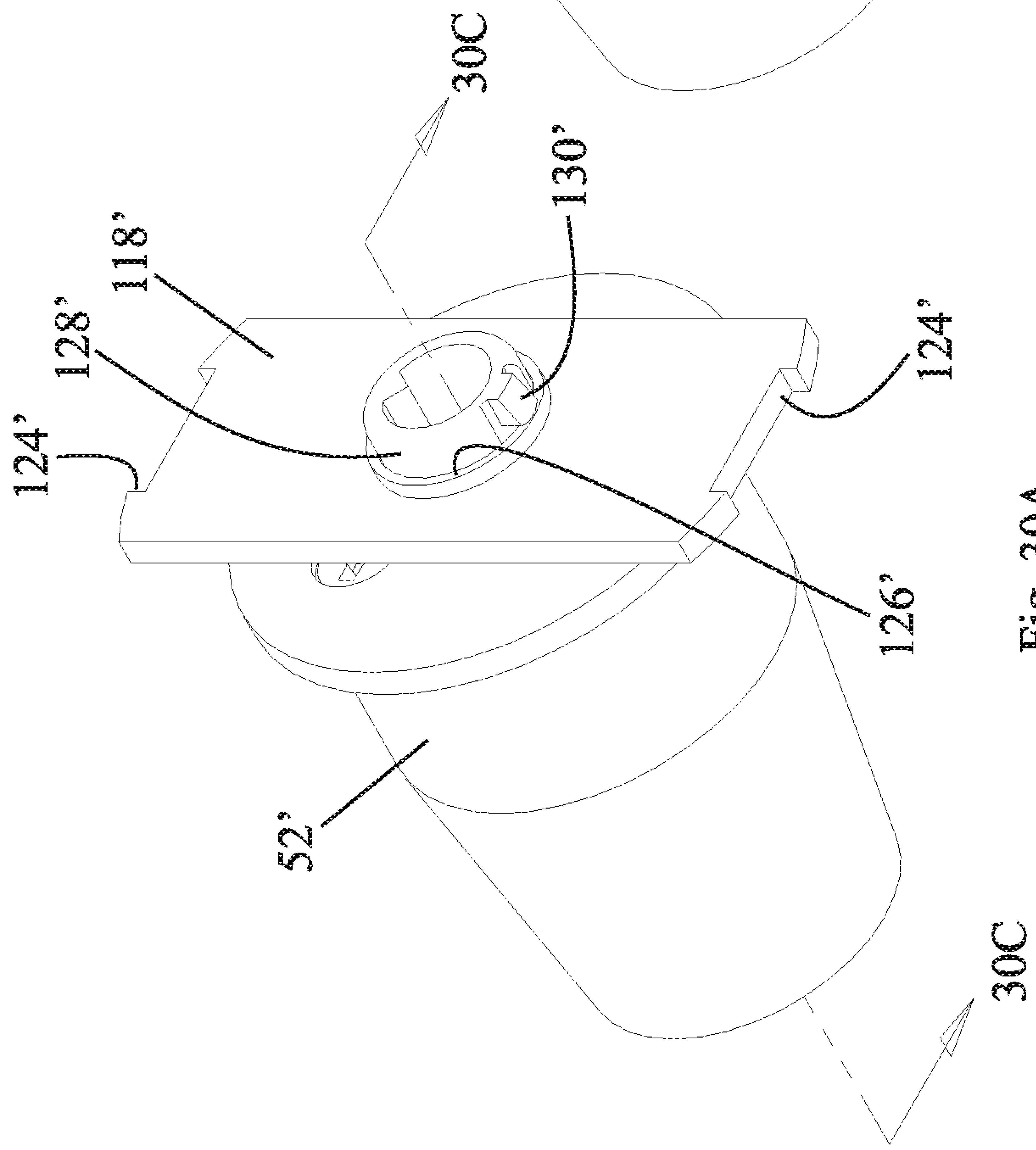

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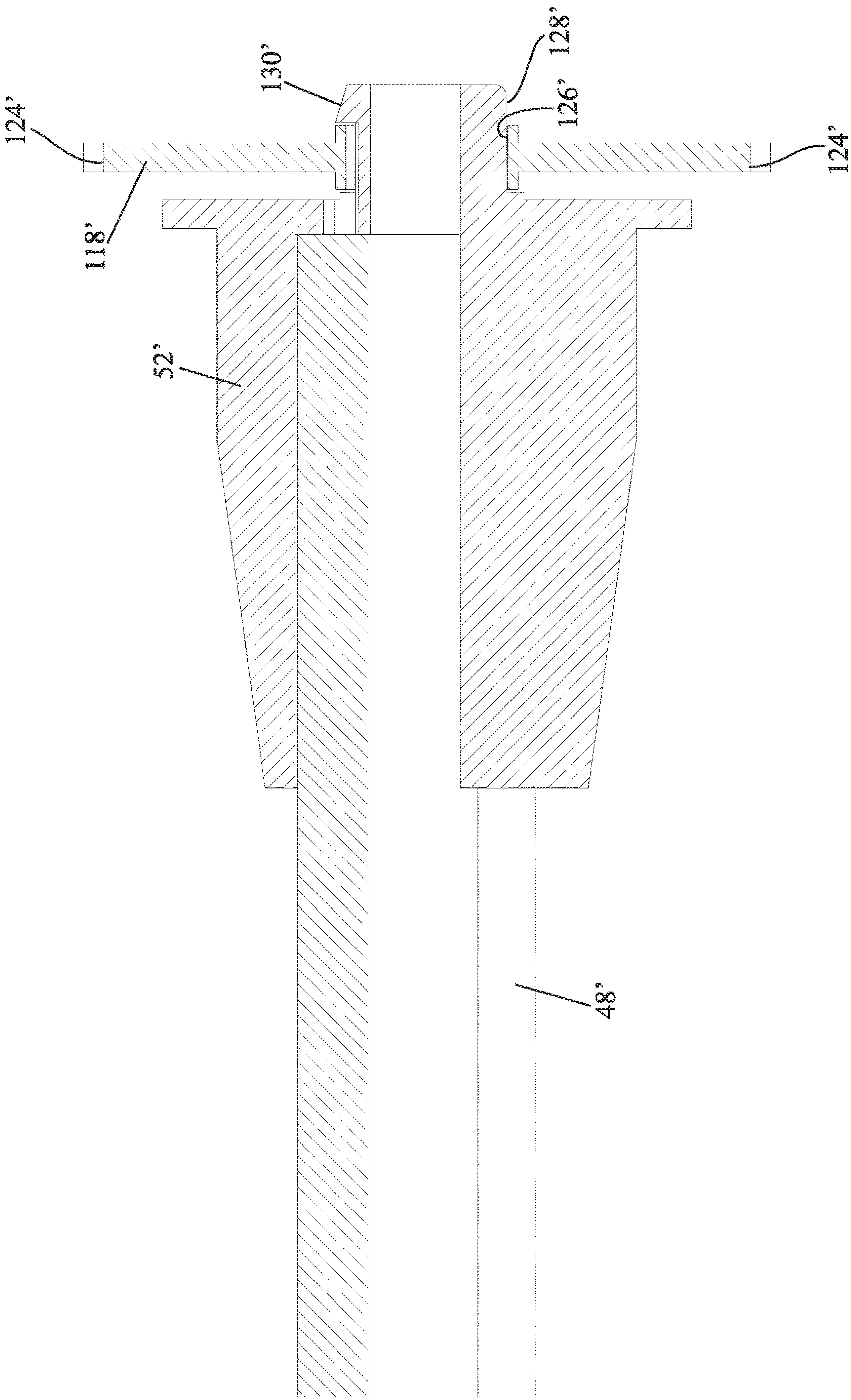

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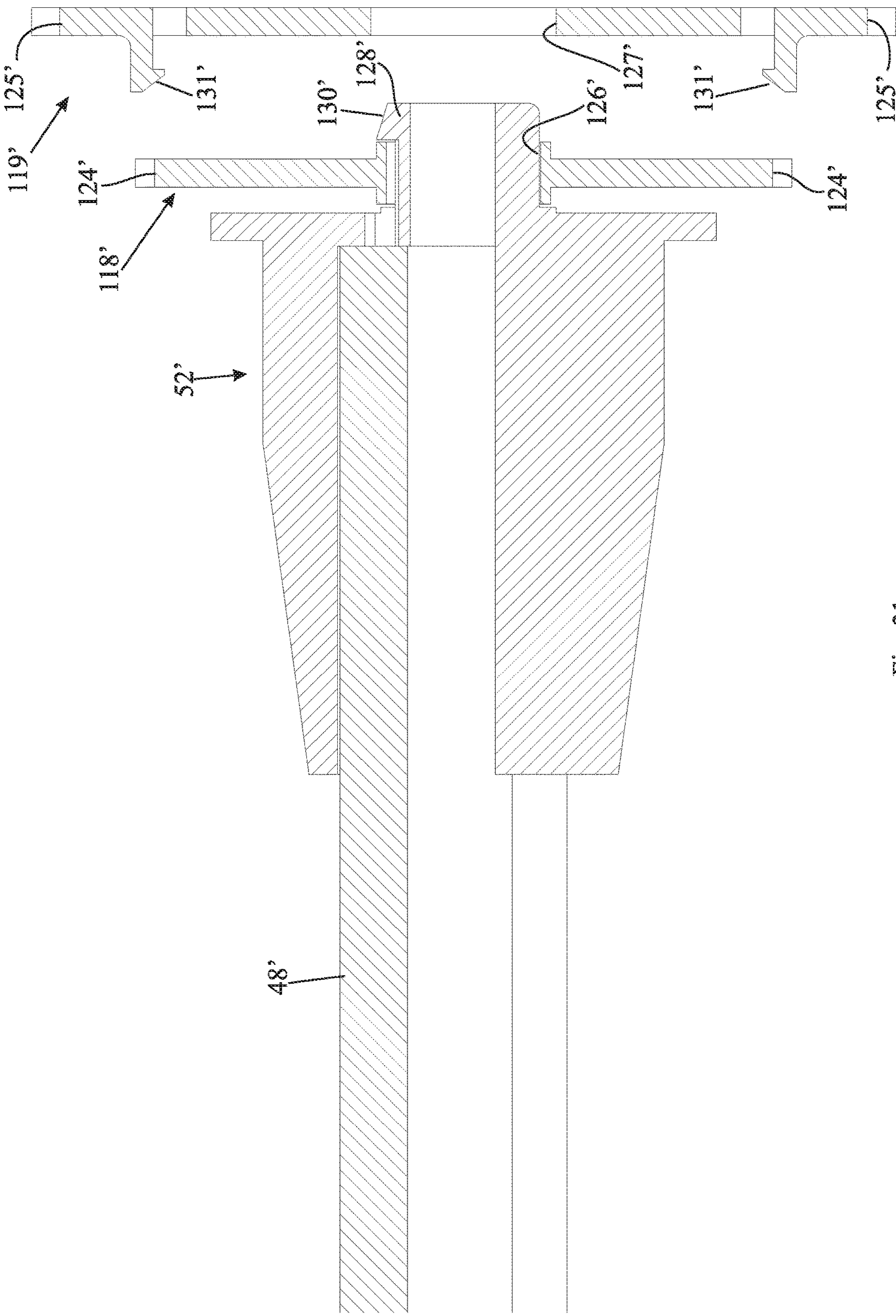

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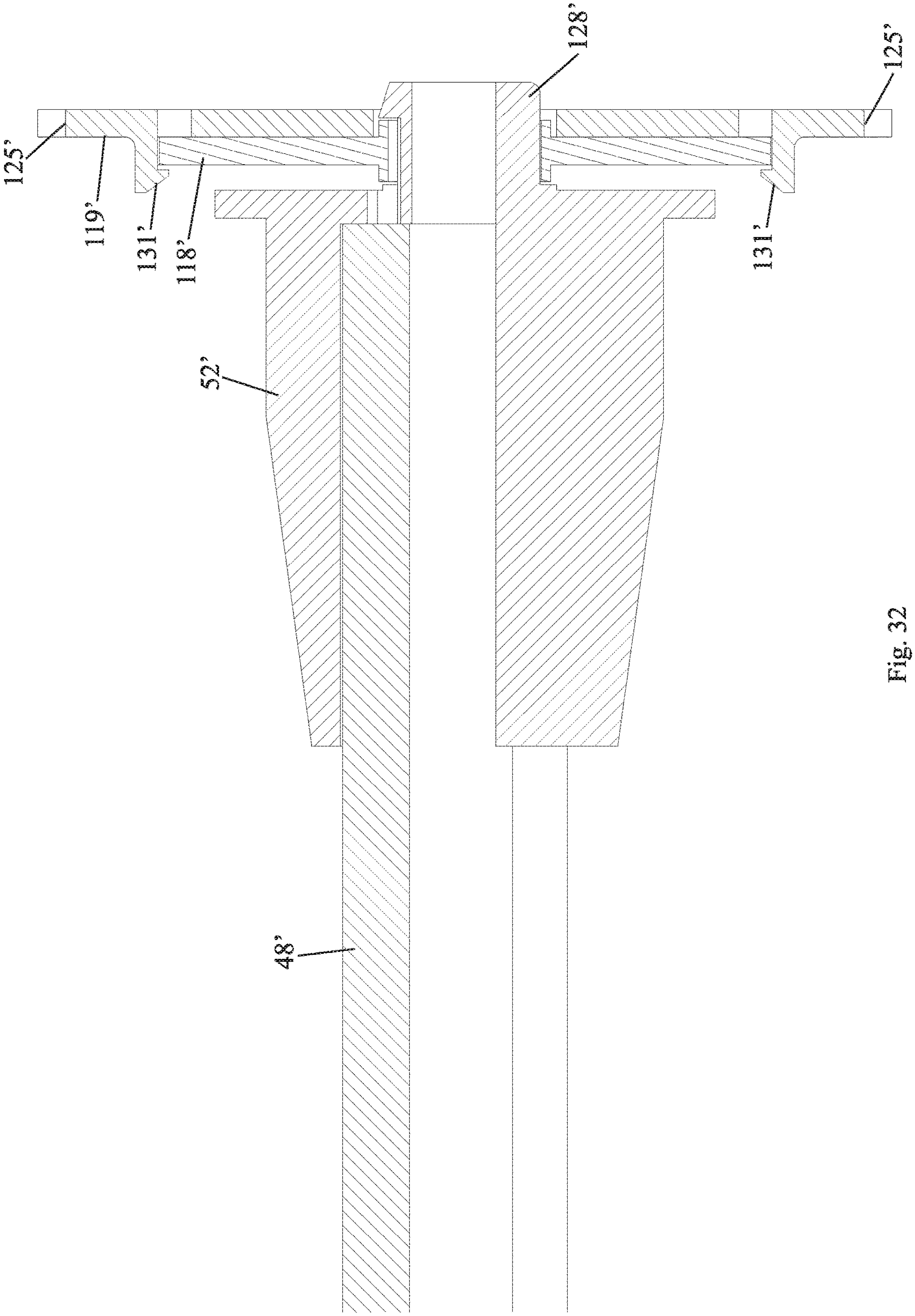

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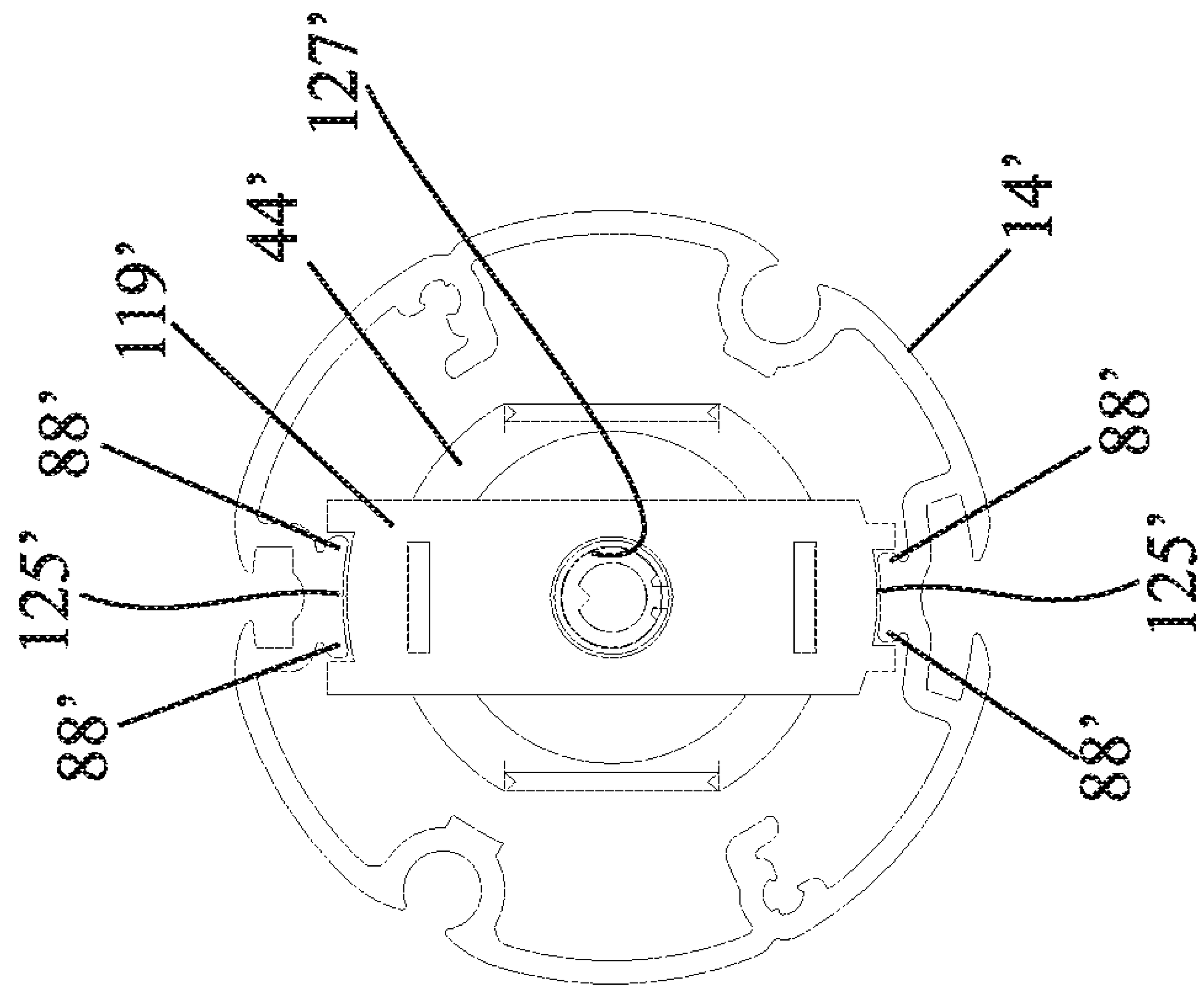

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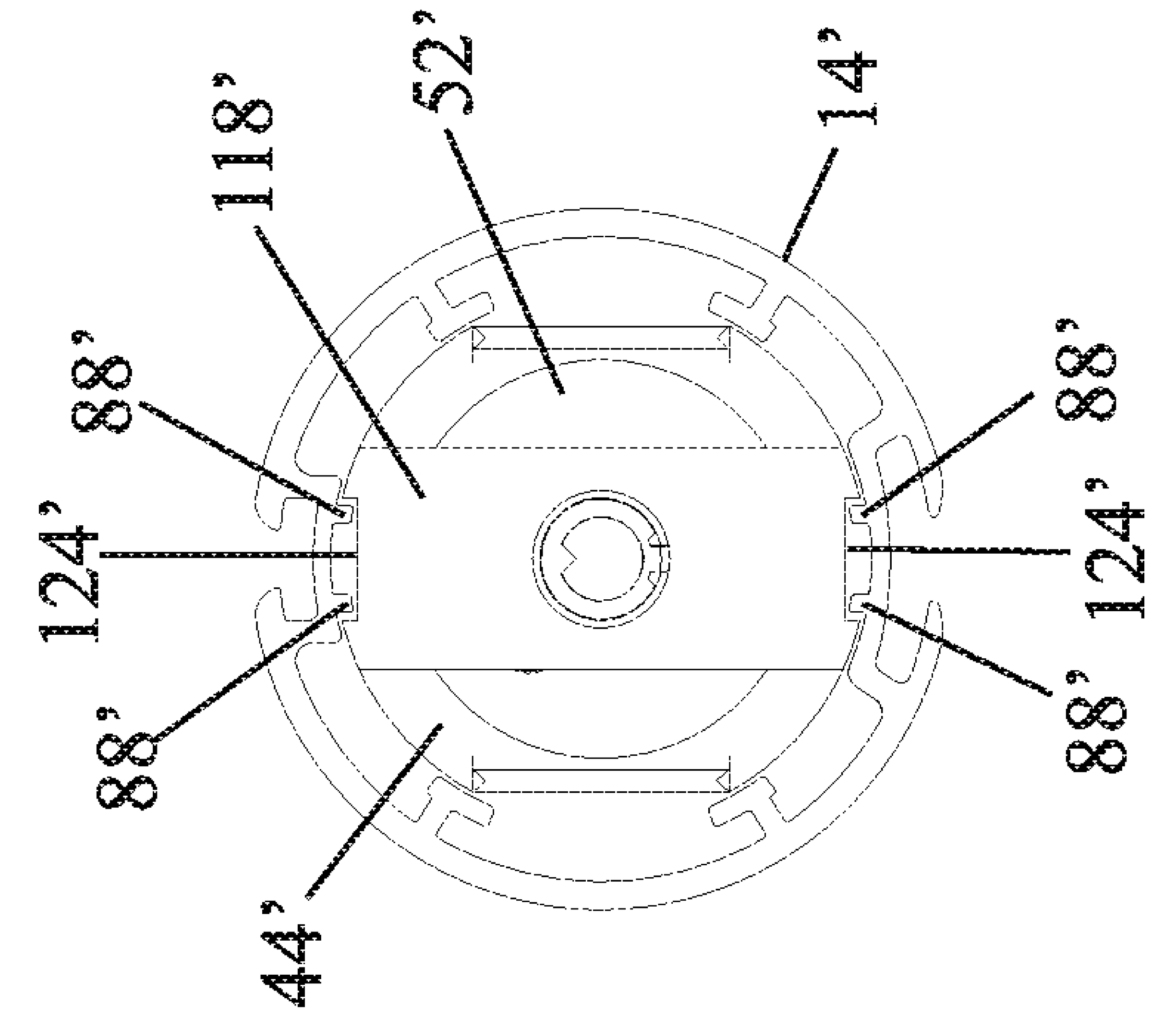

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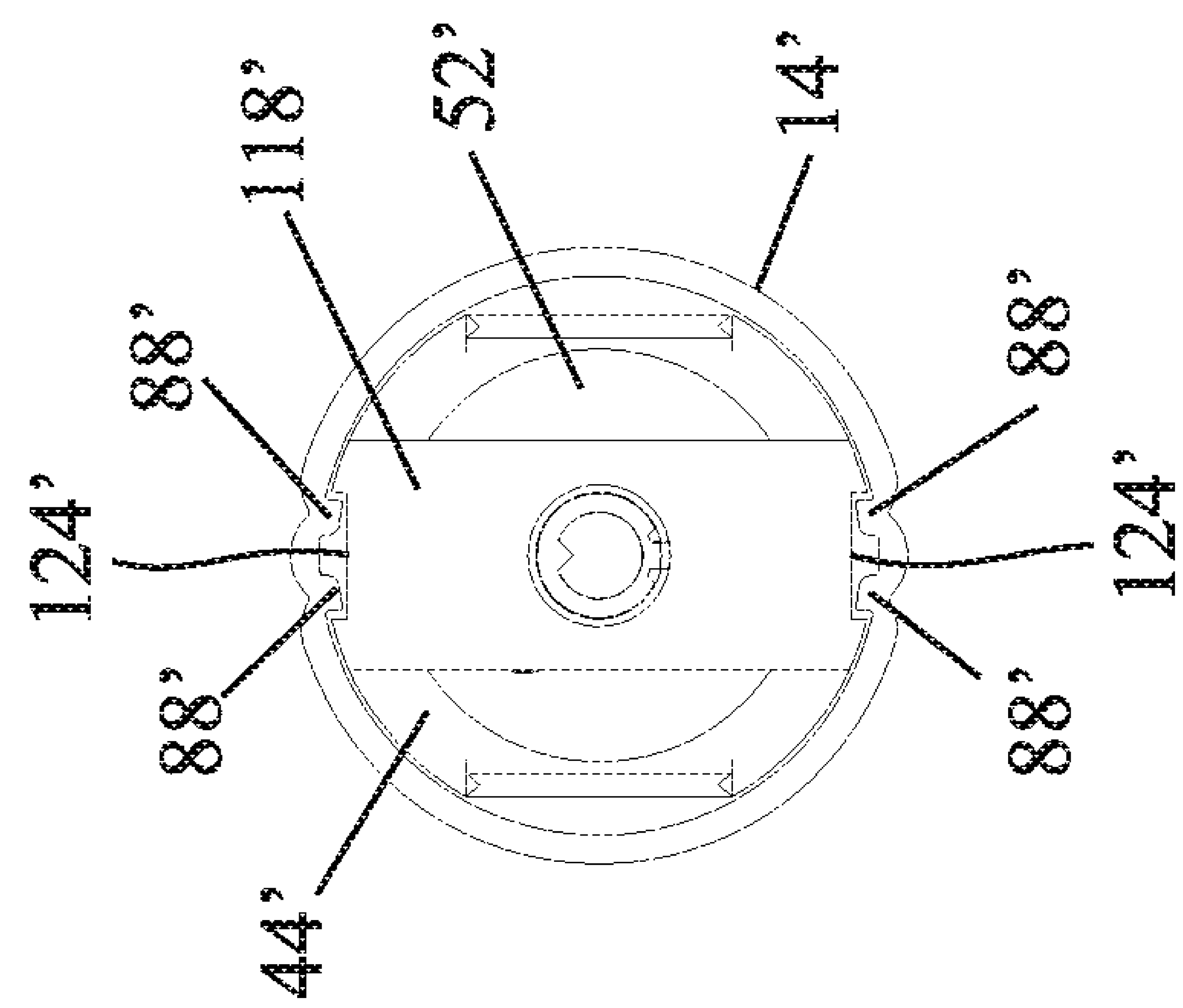

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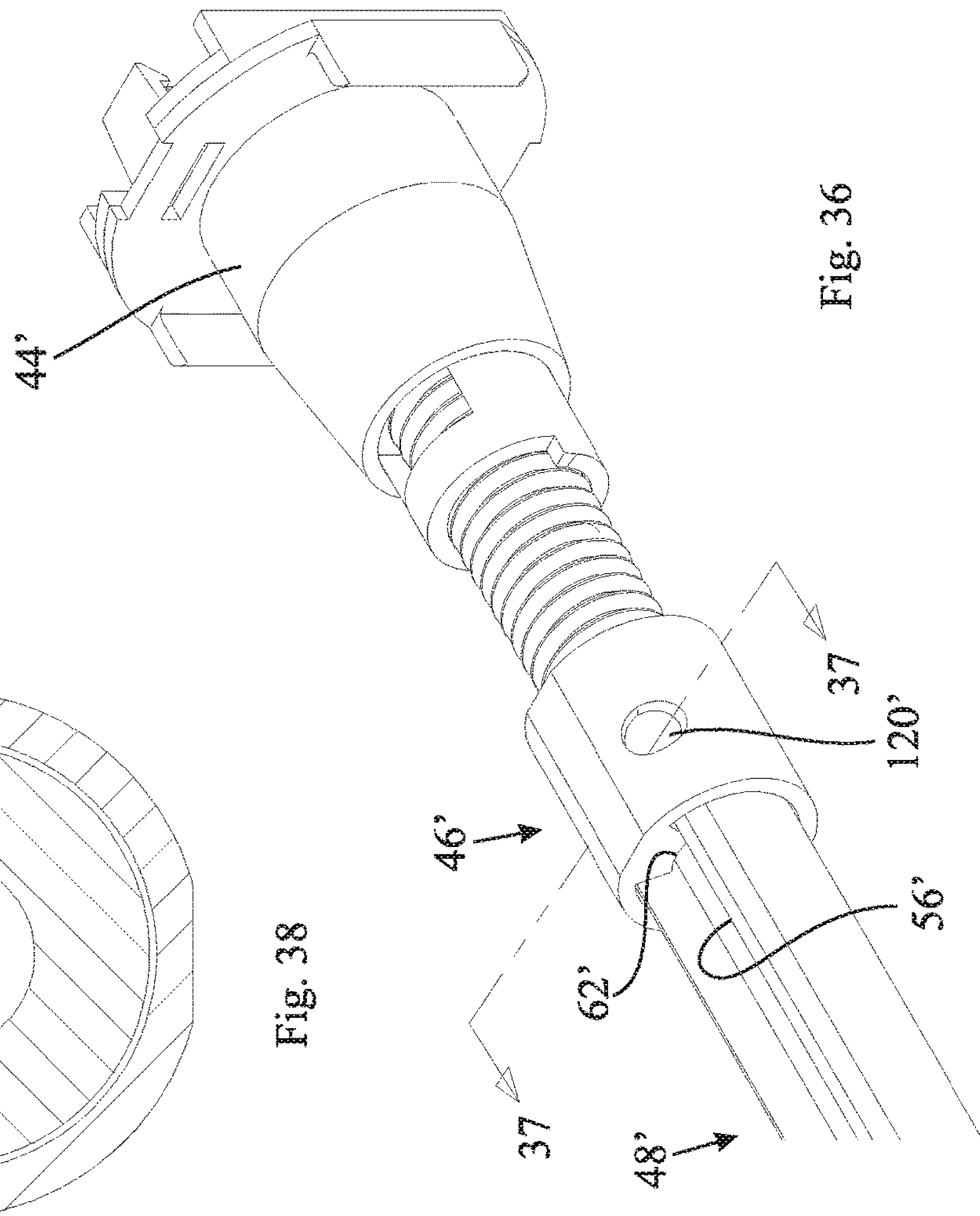

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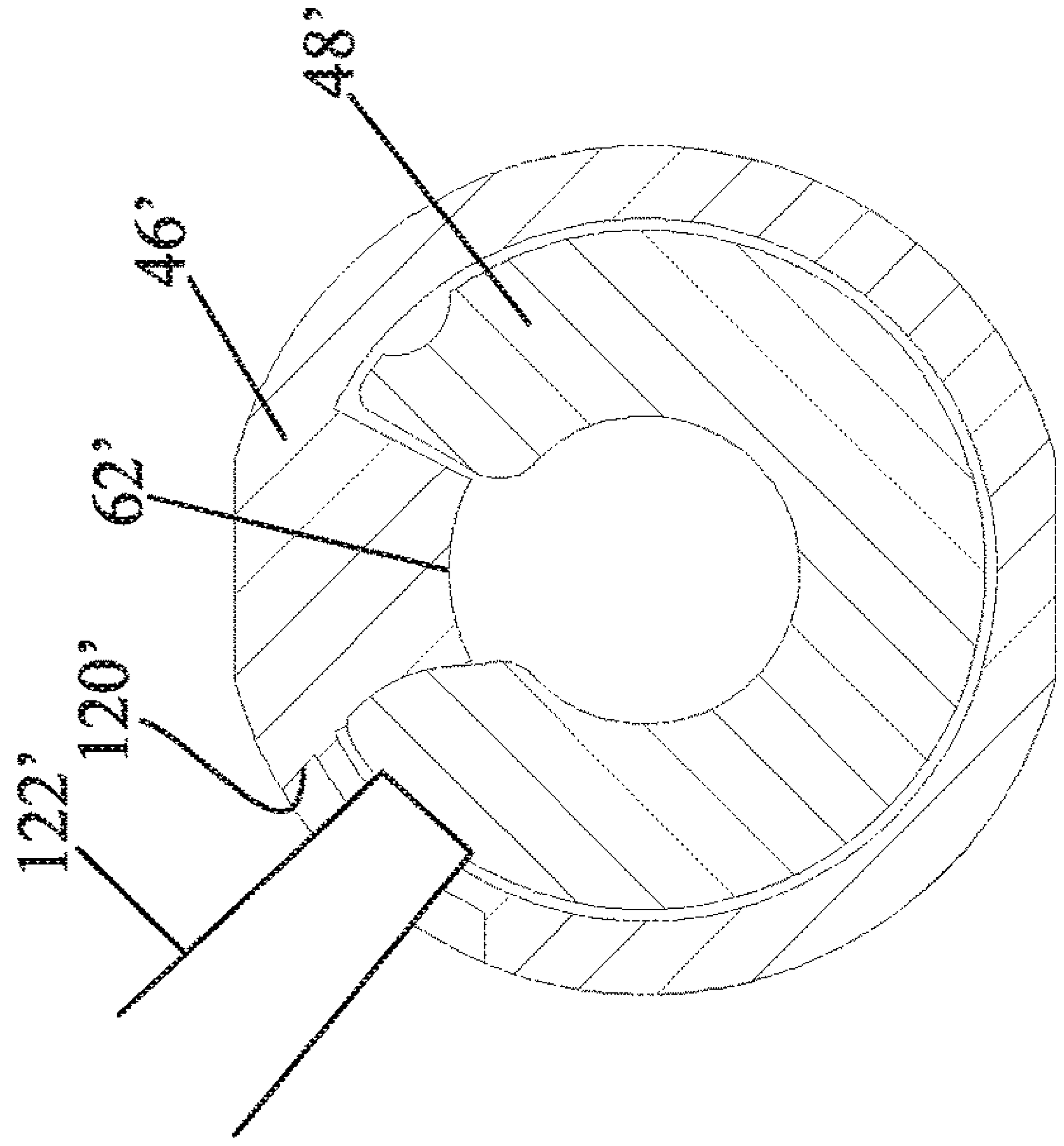

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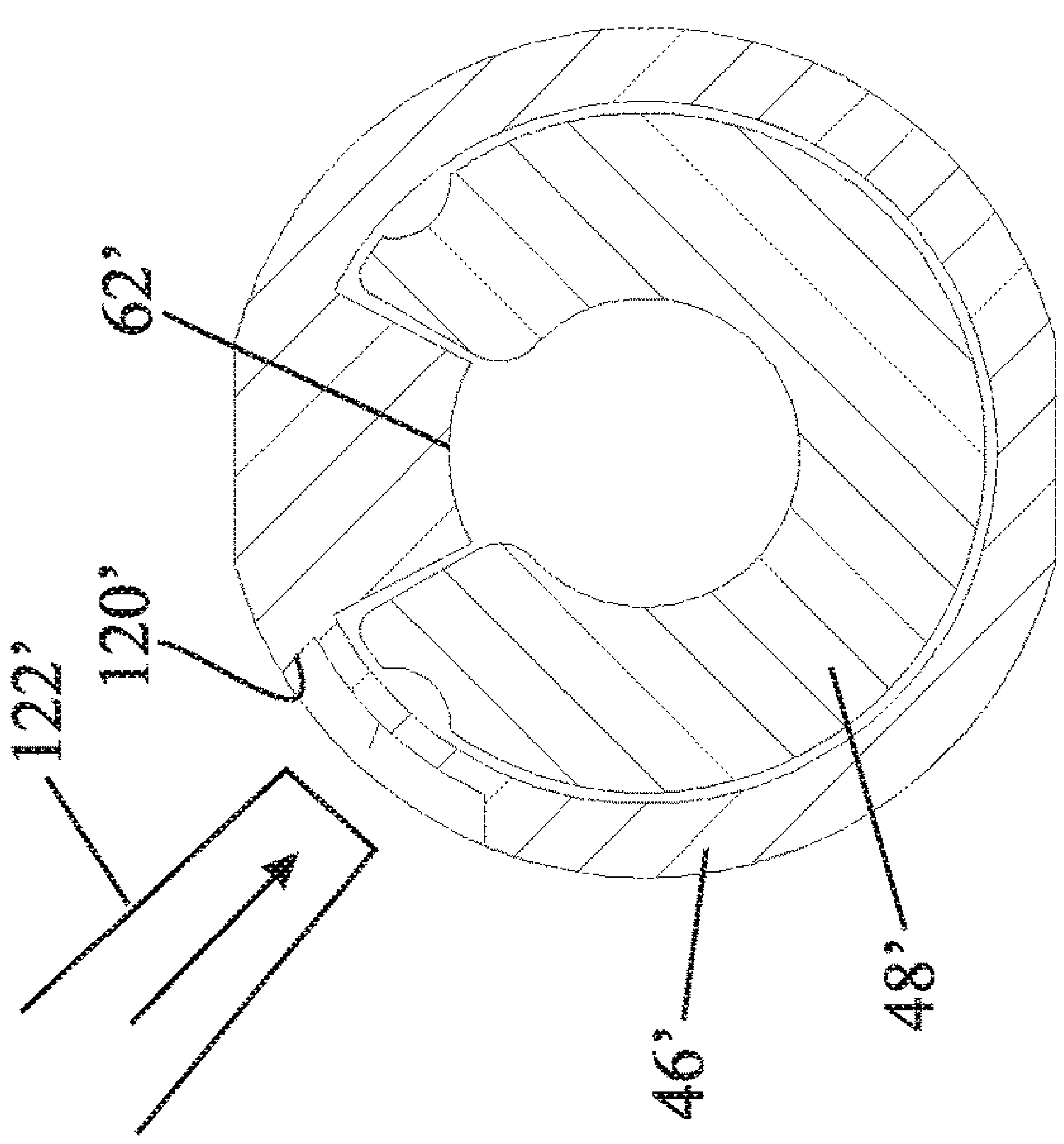

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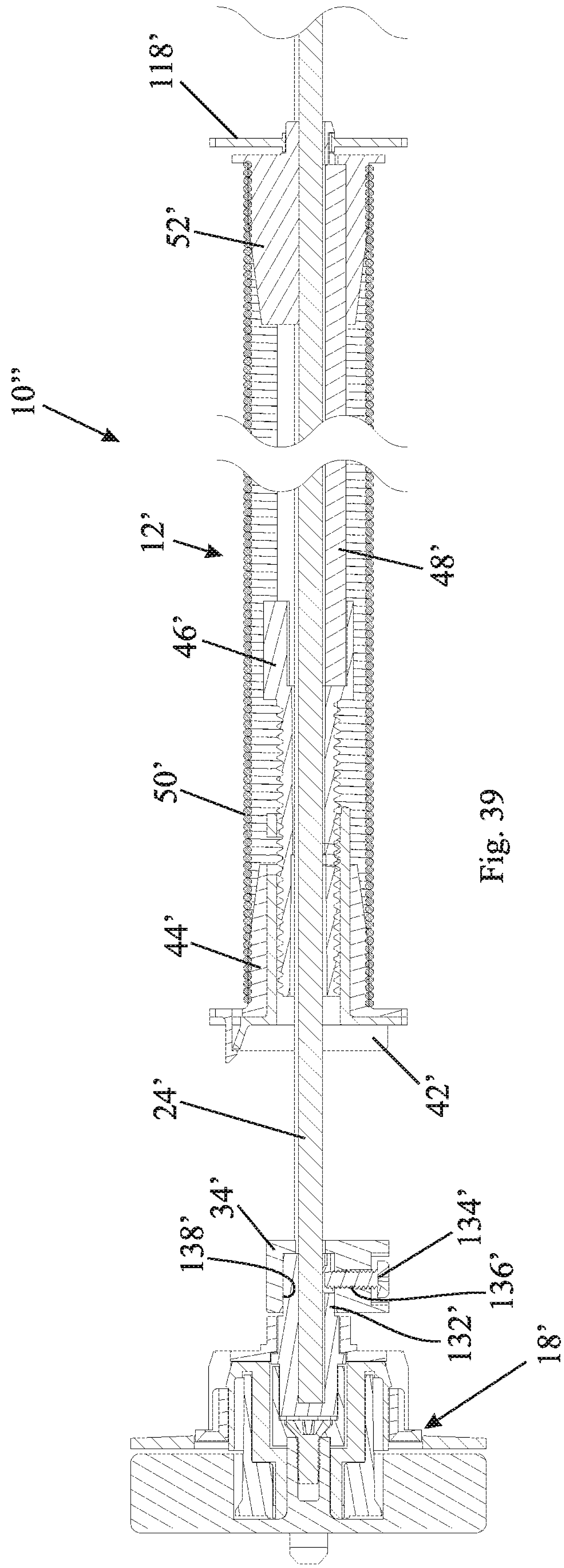

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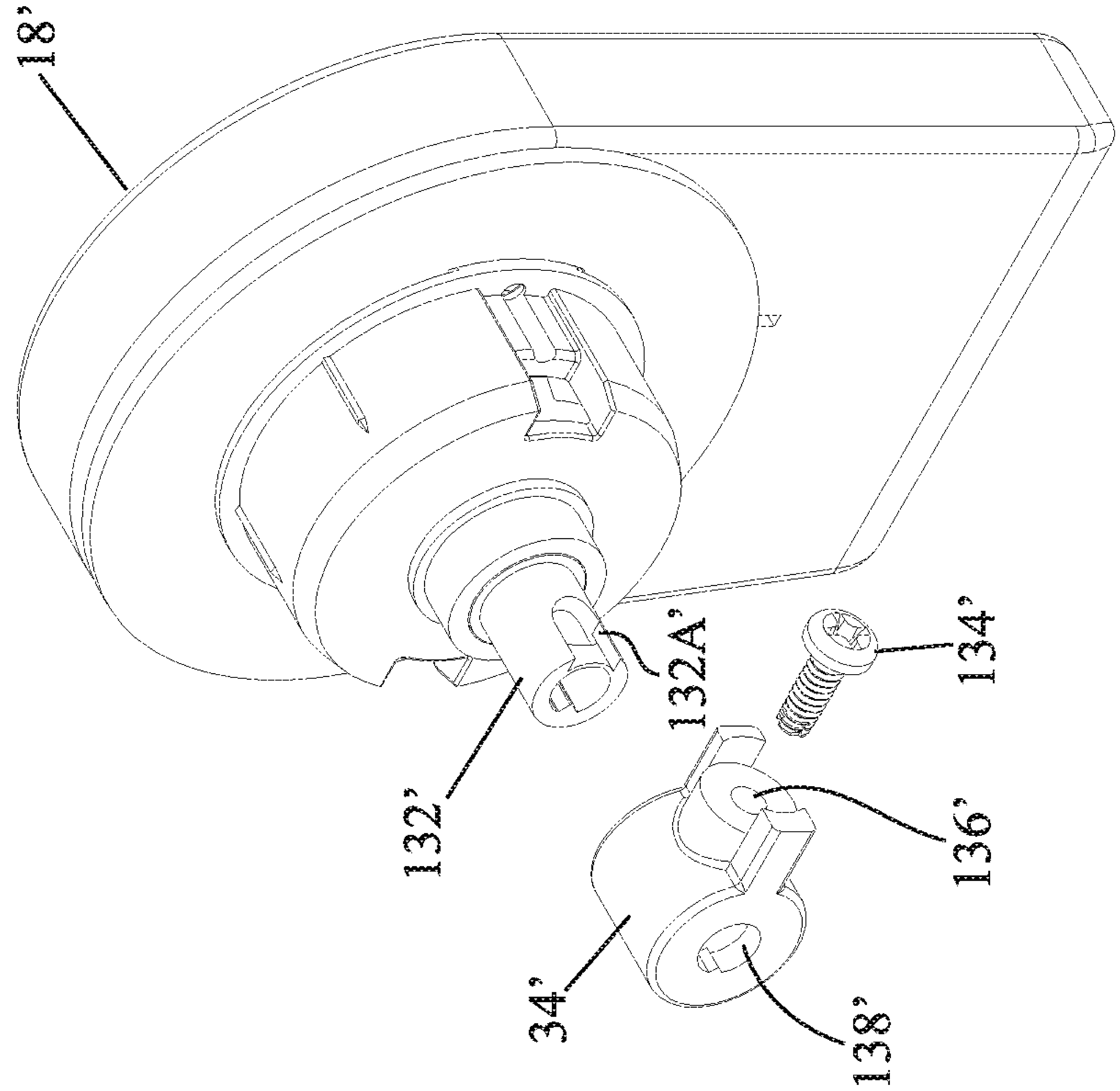

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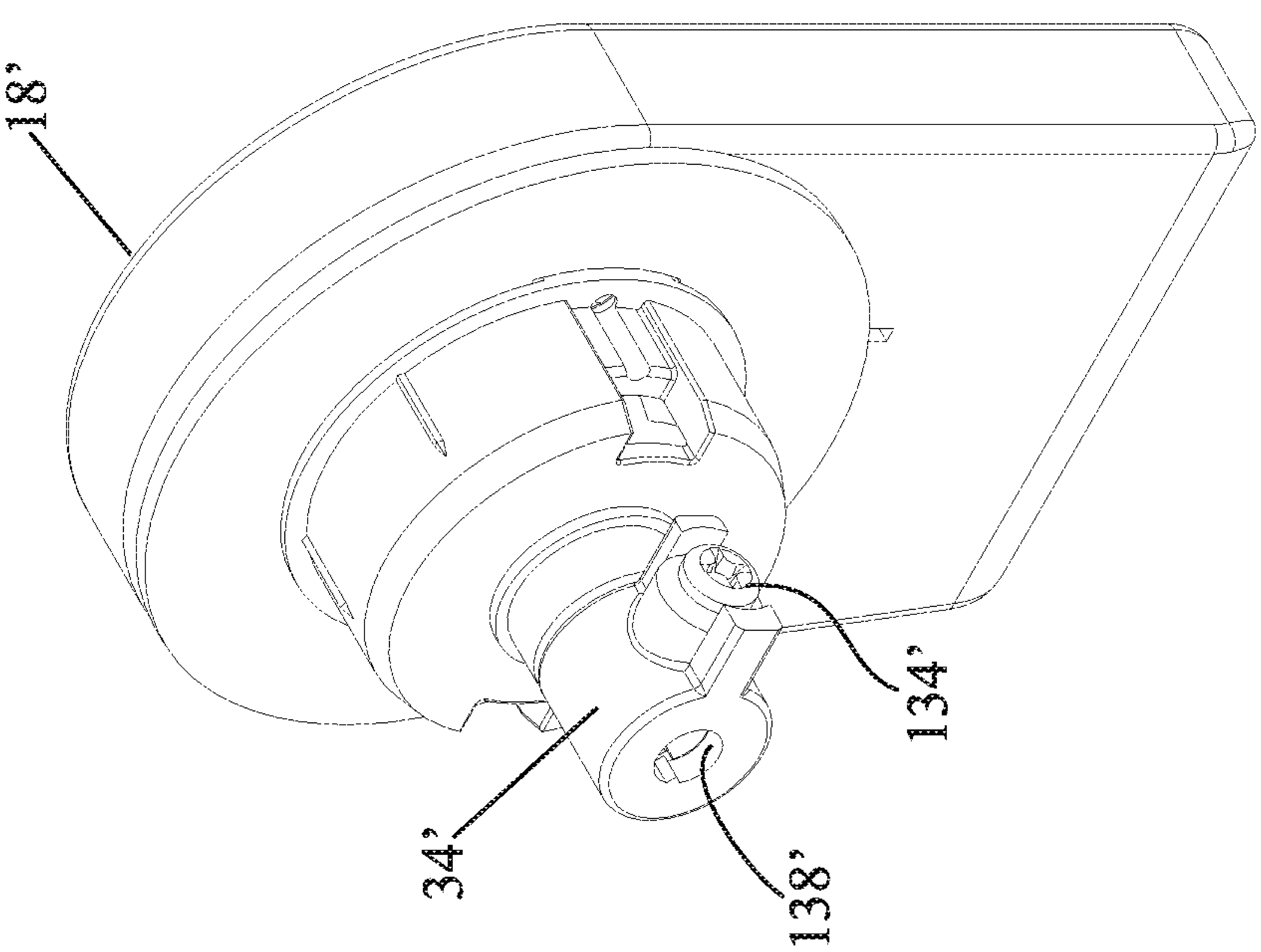

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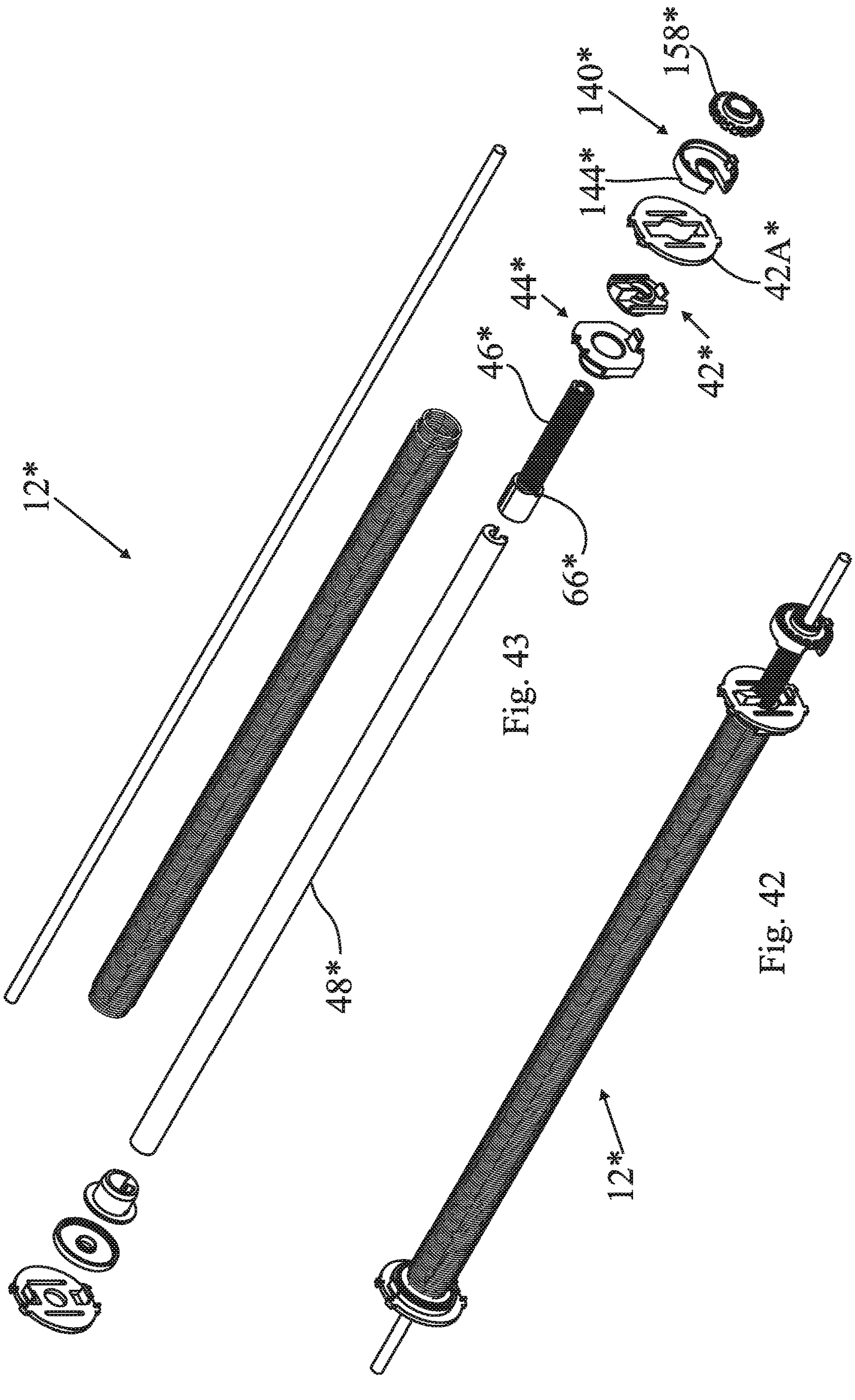

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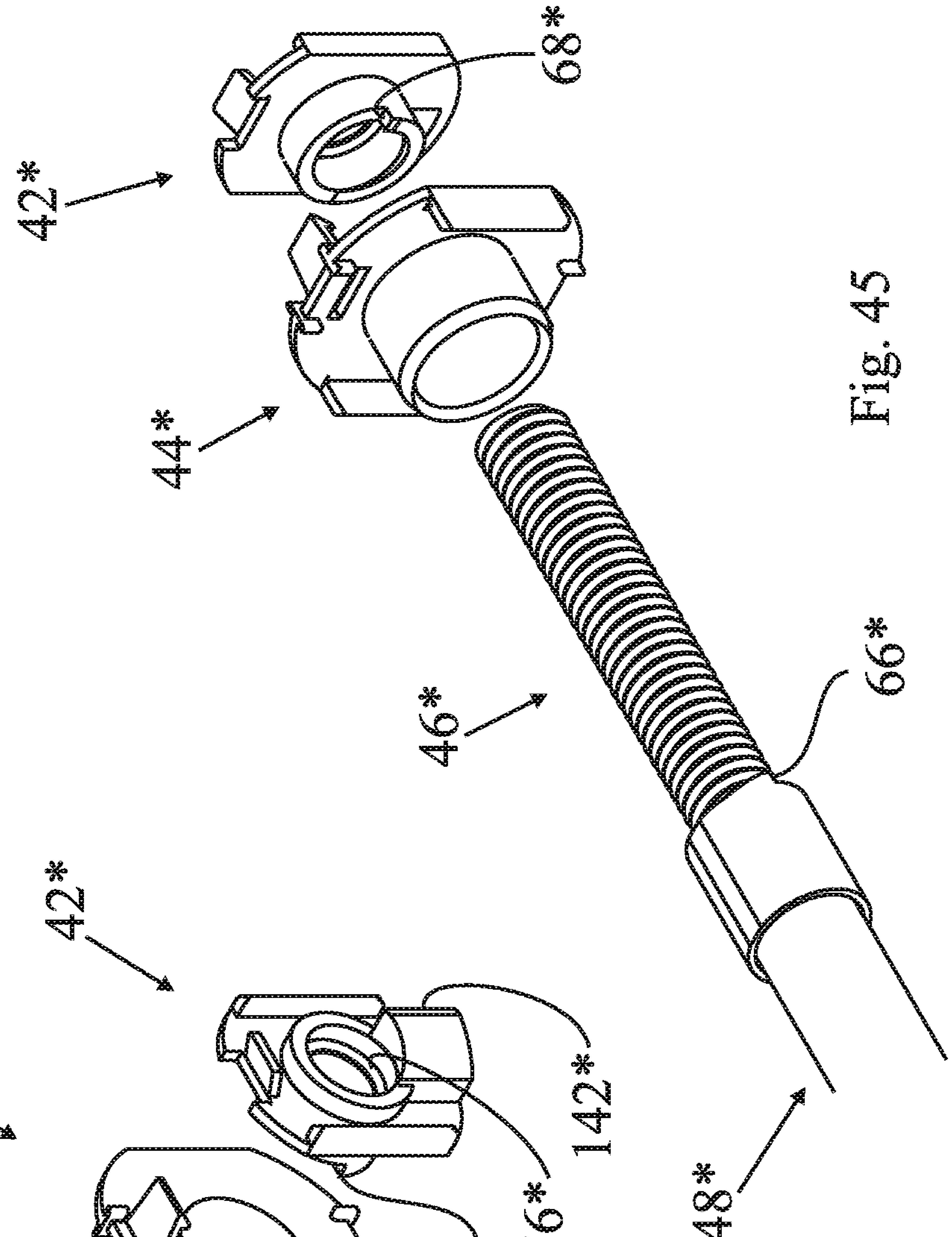

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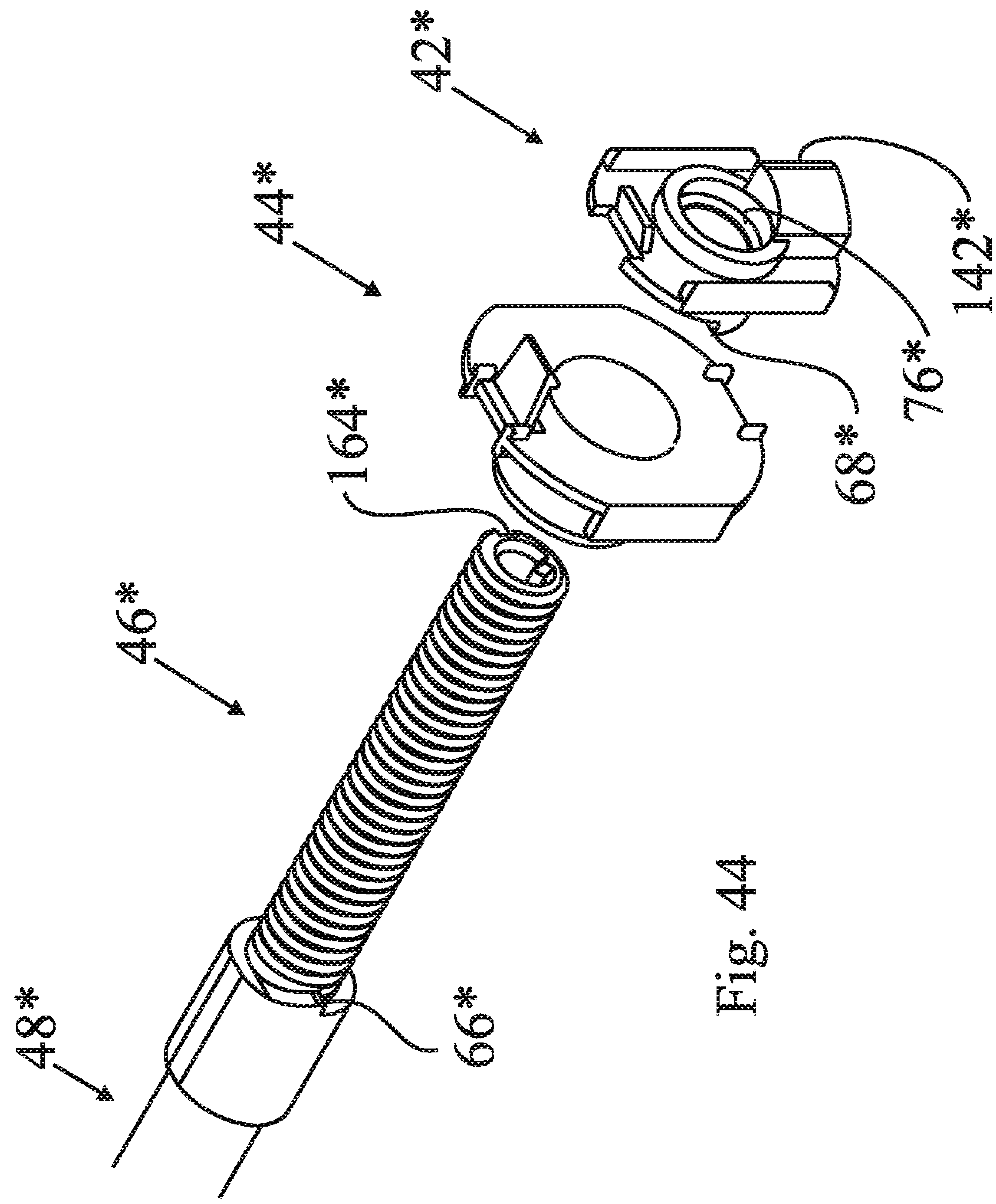

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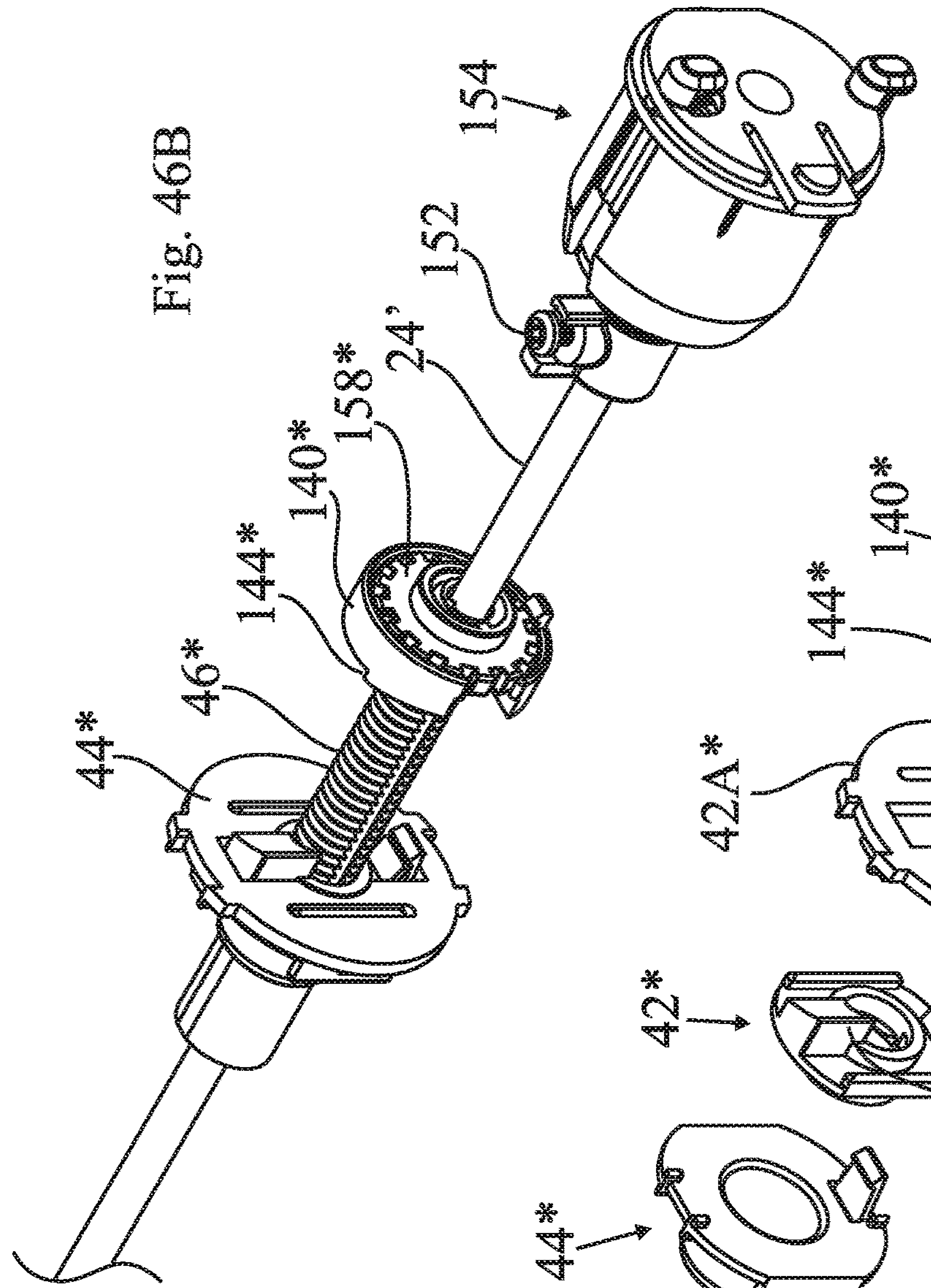

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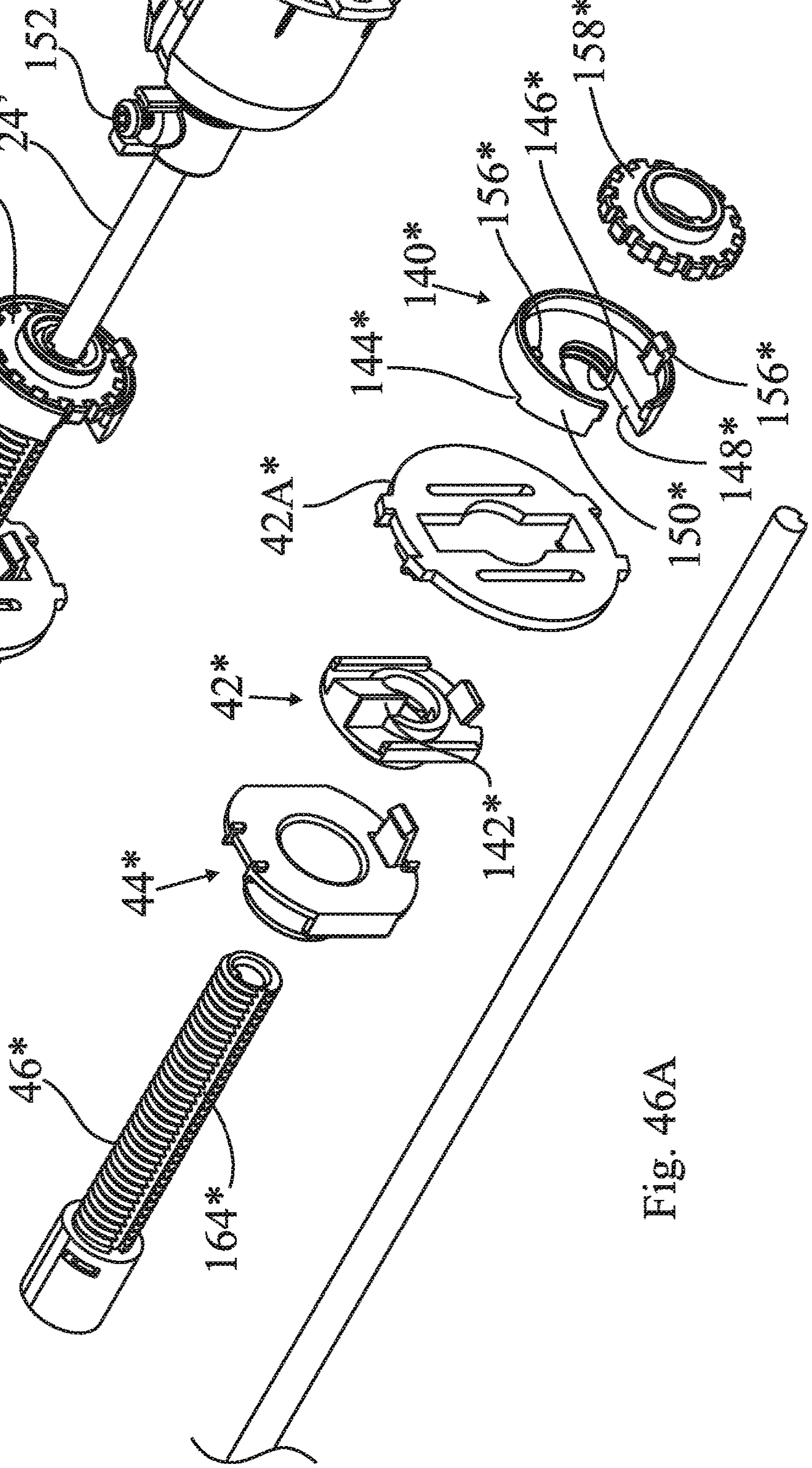

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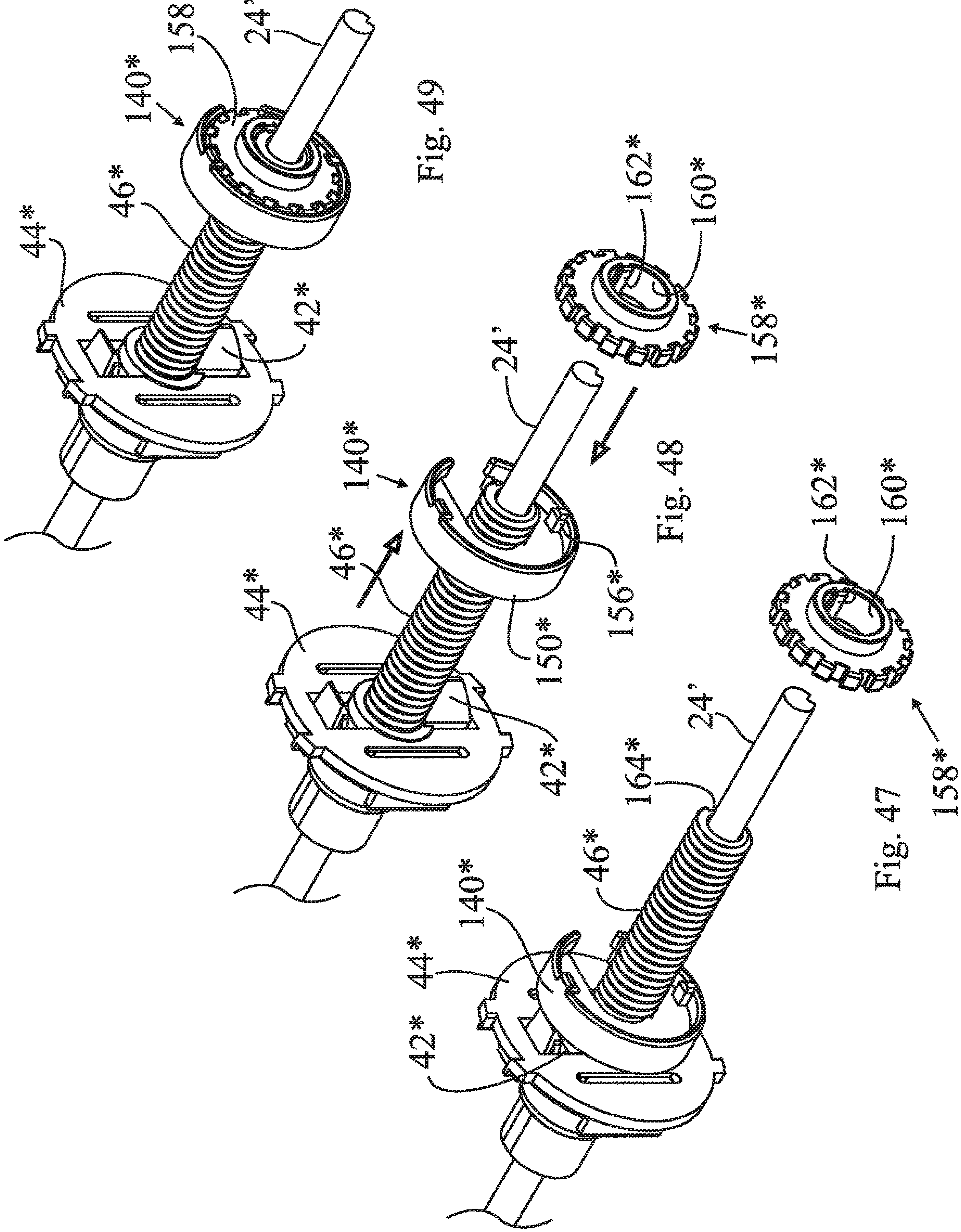

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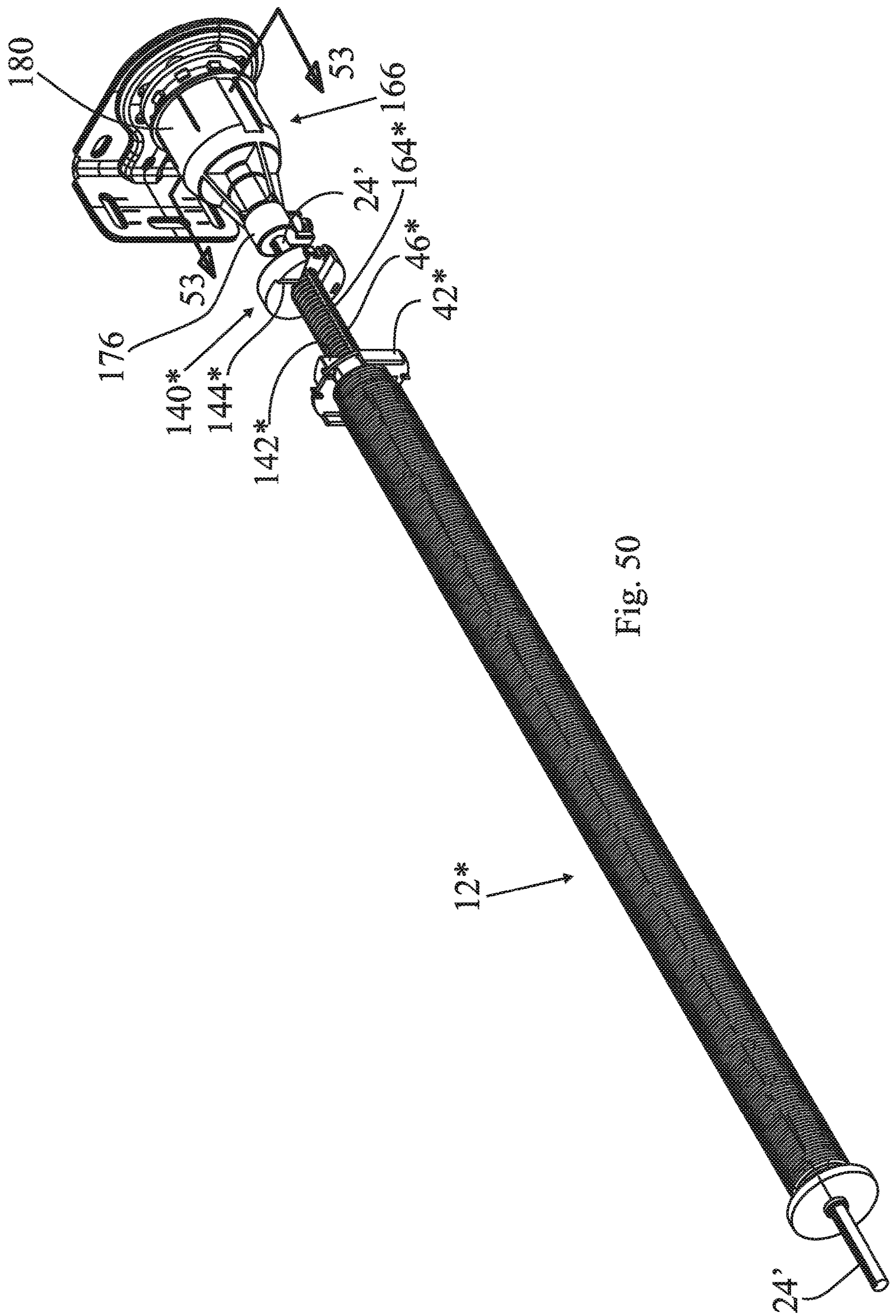

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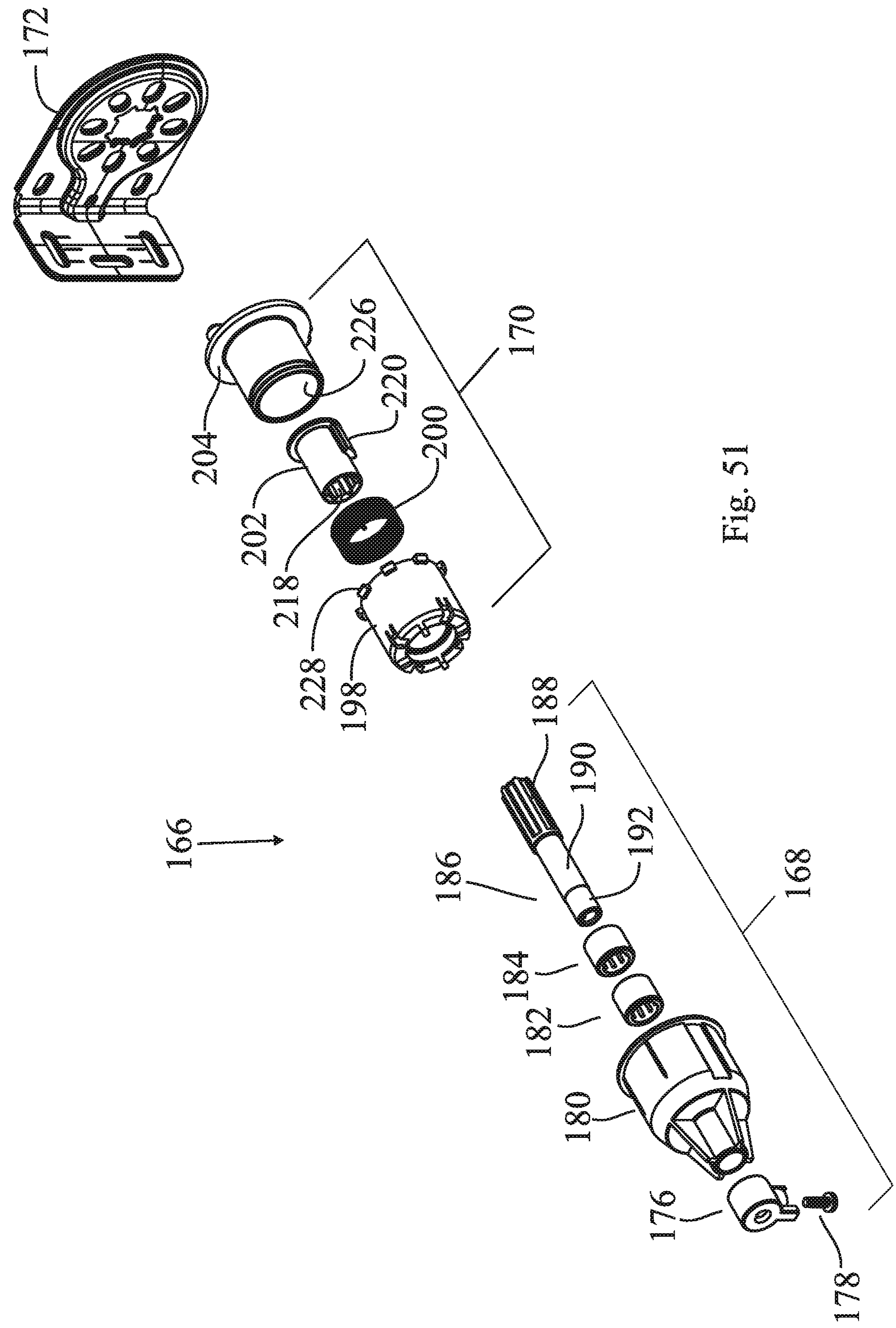
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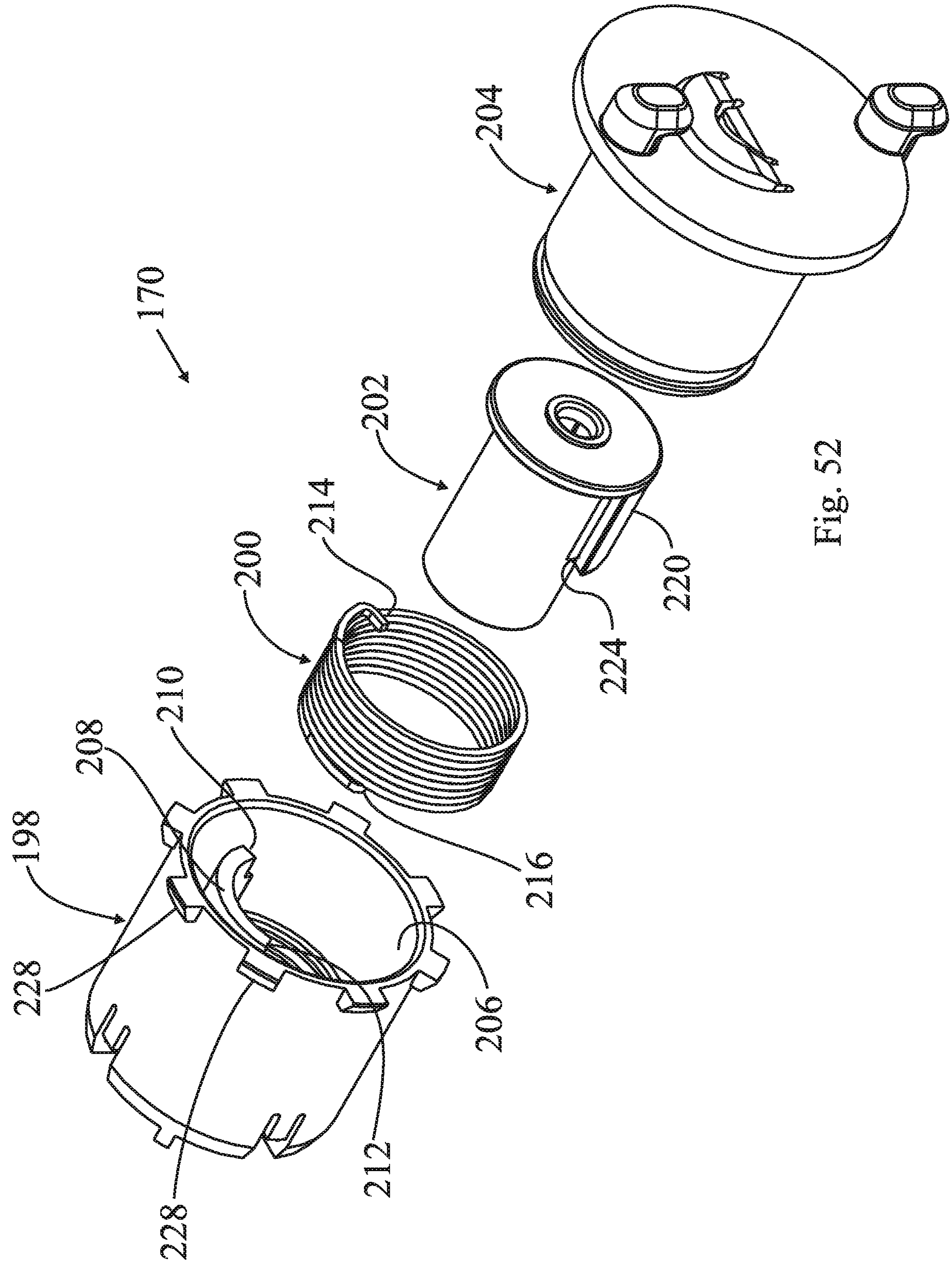
Fig. 51



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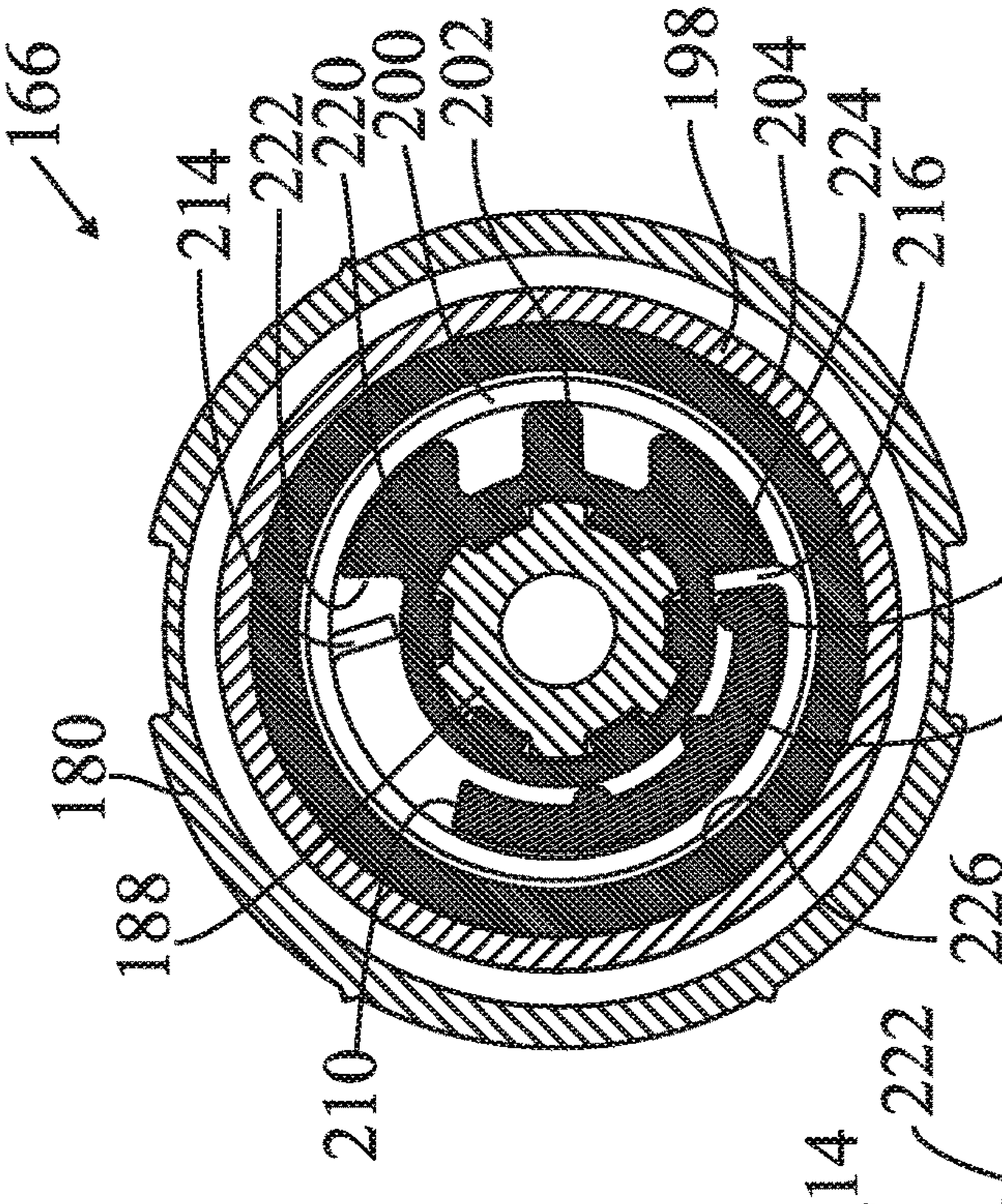

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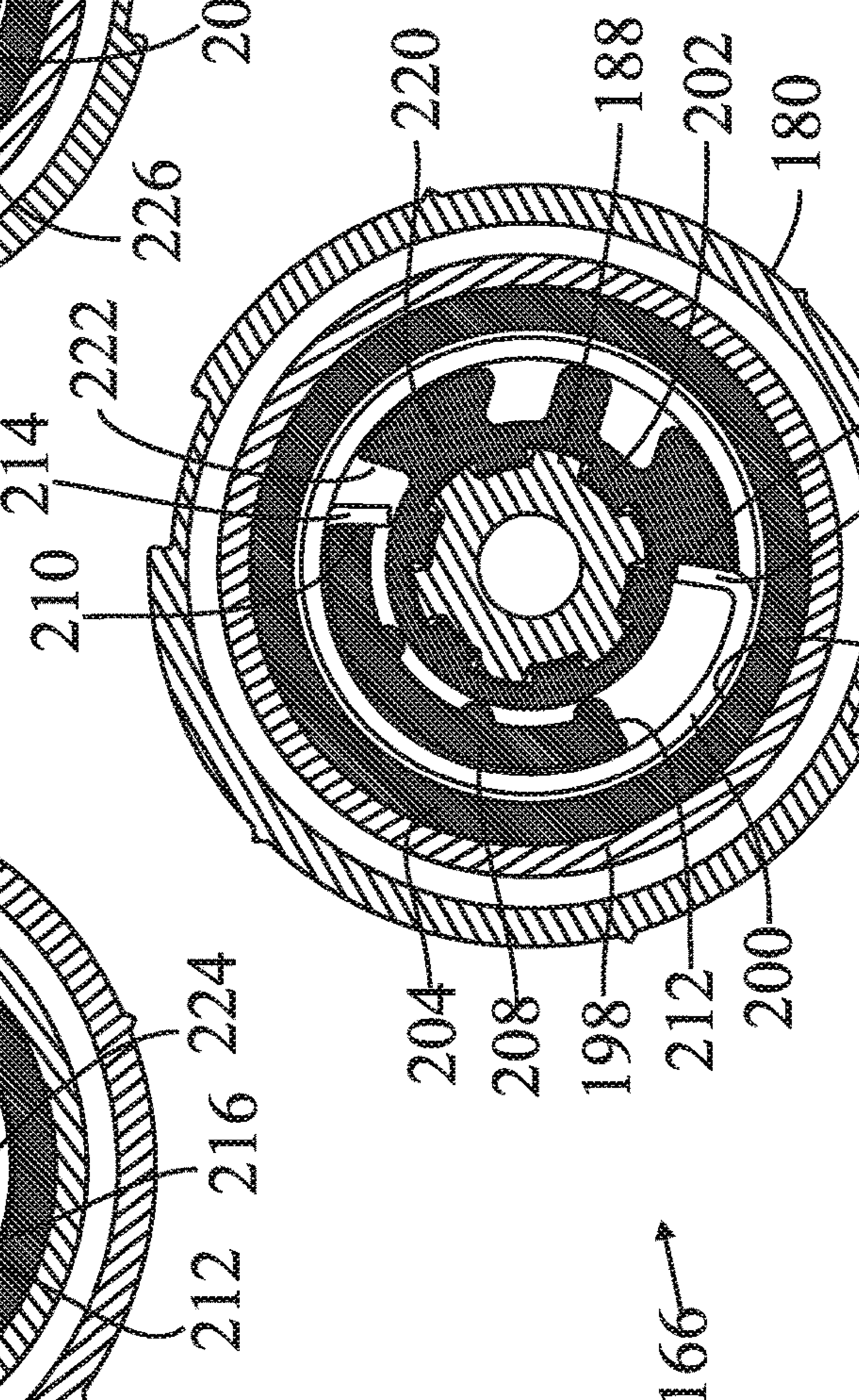

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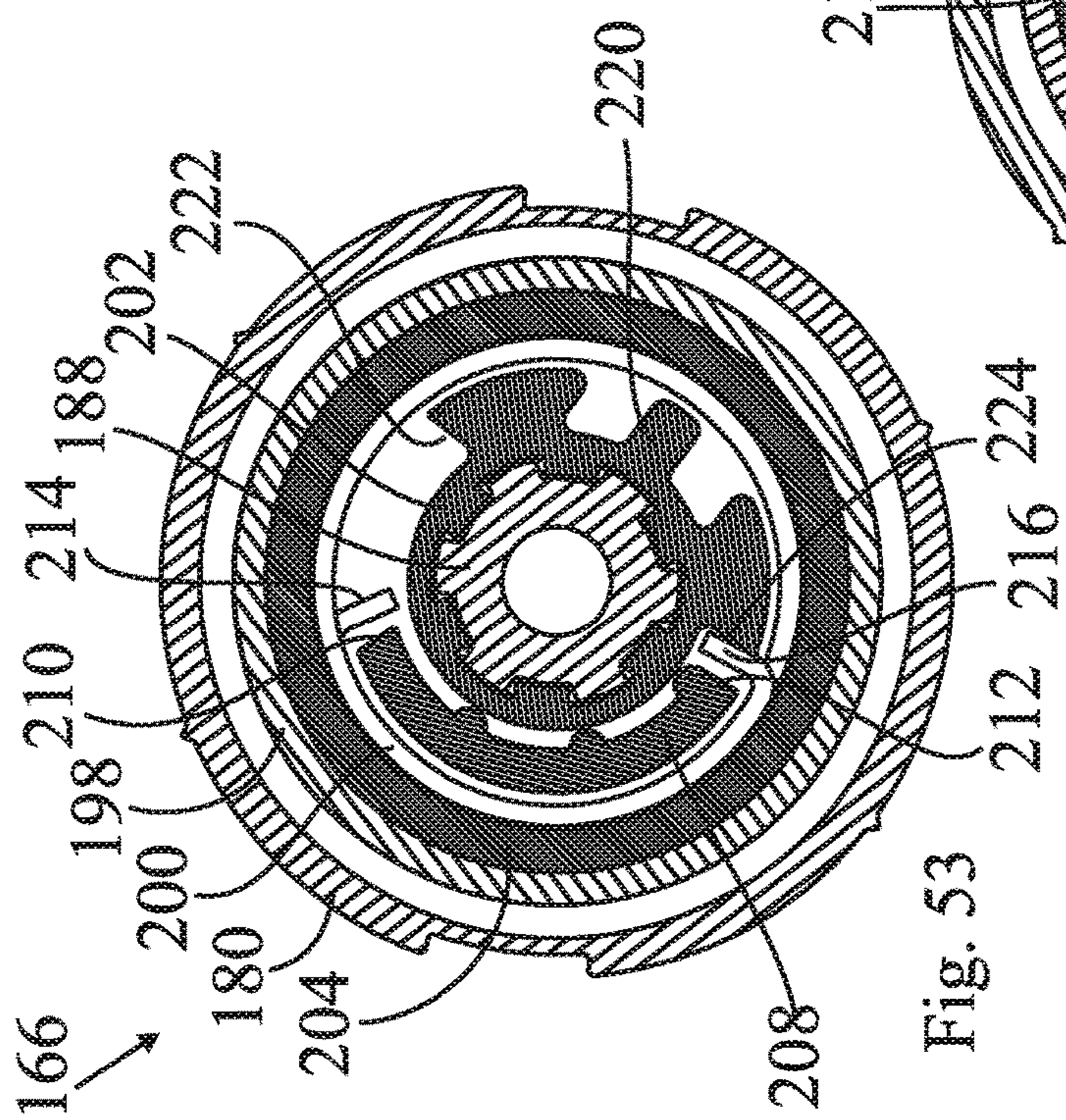

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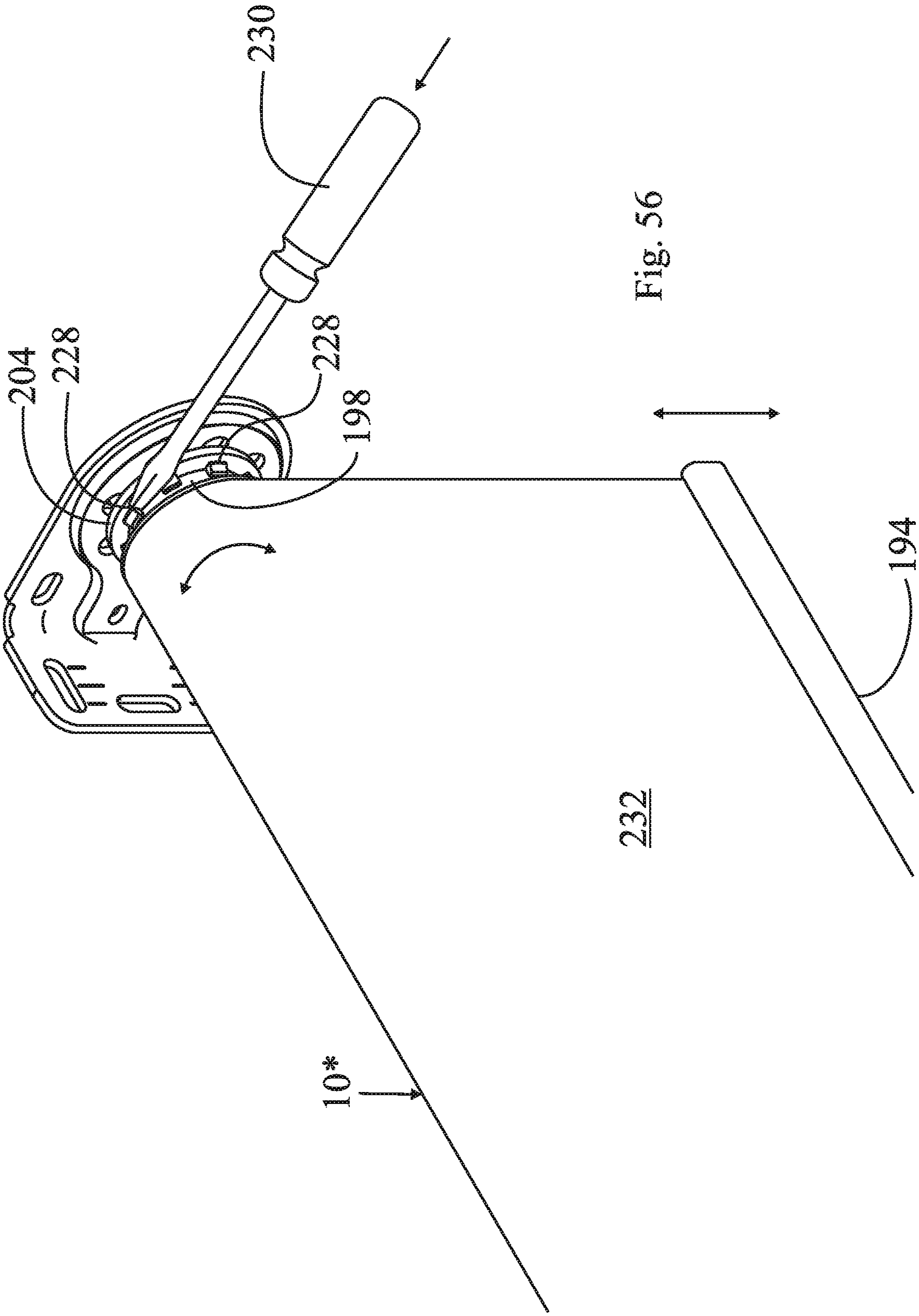

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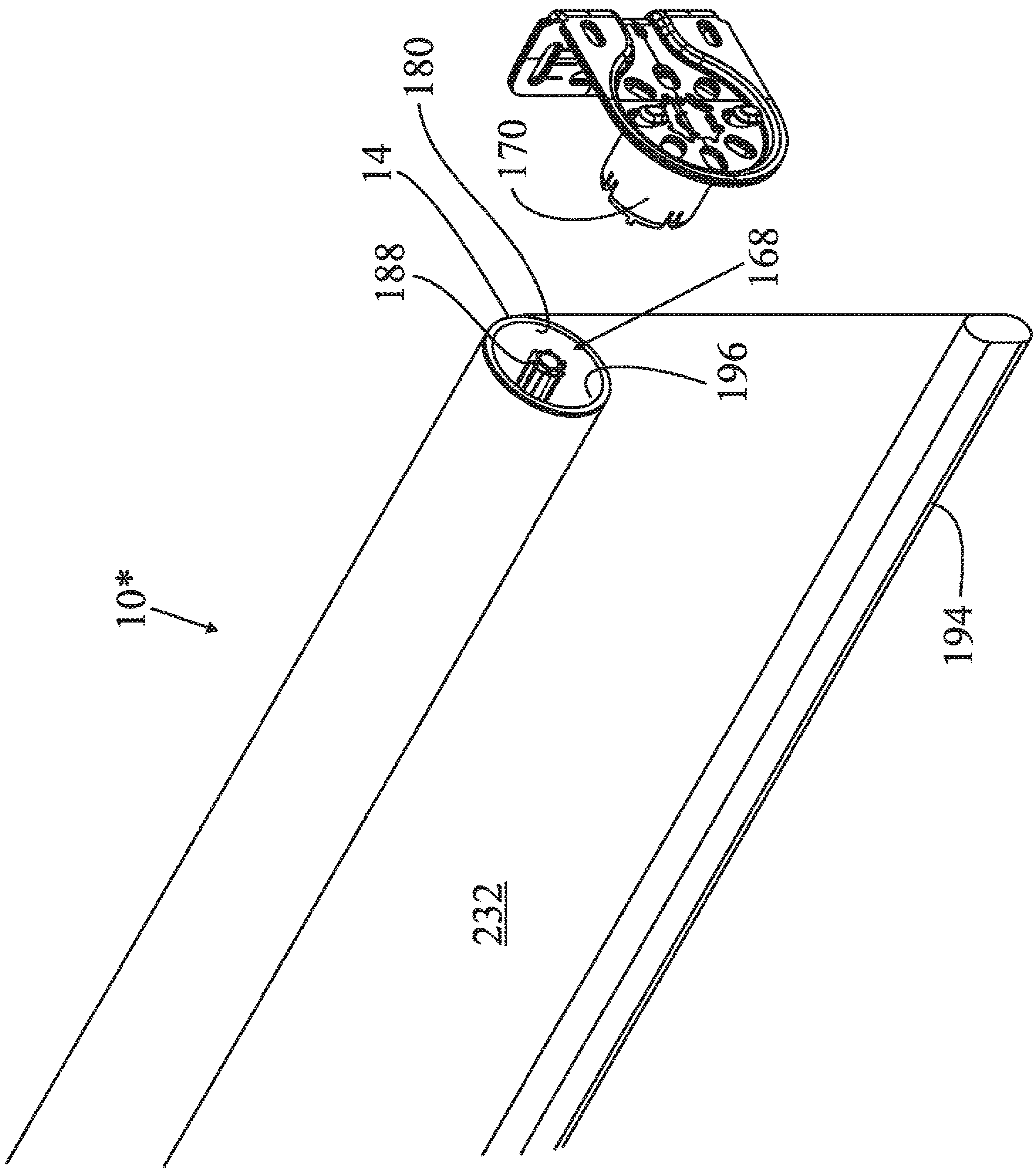

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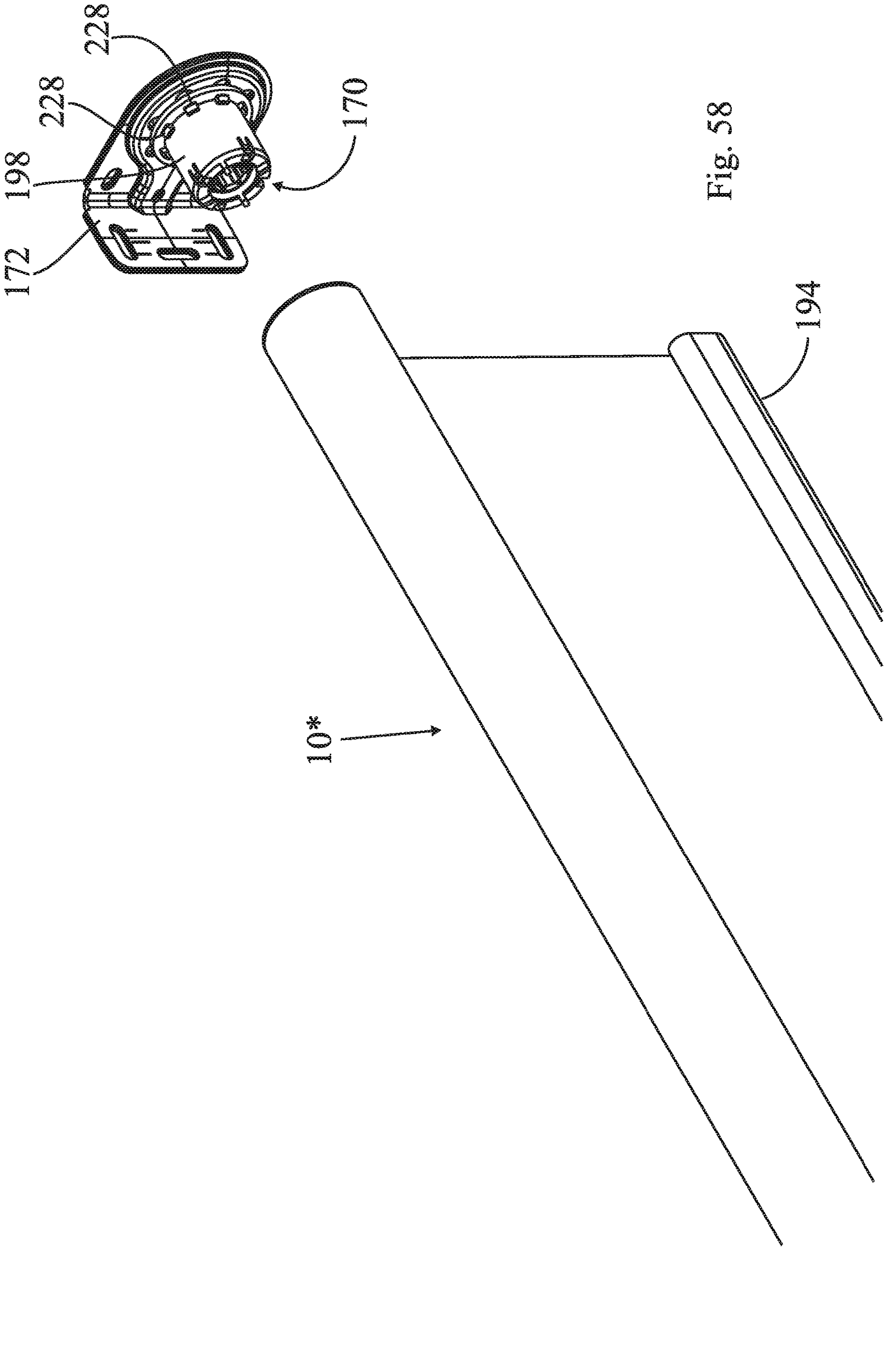

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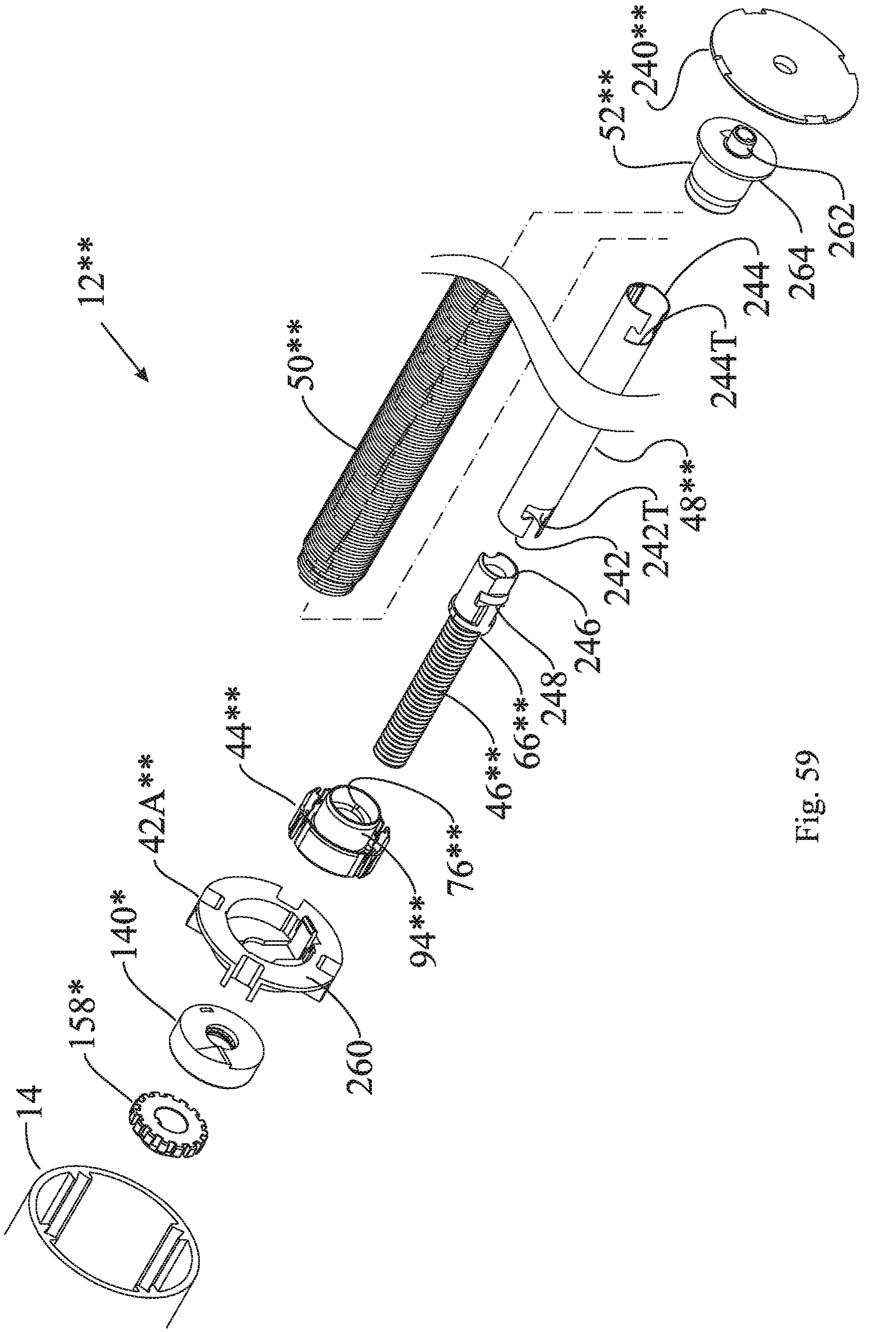
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42A**
140*
158*
260
14

Fig. 59

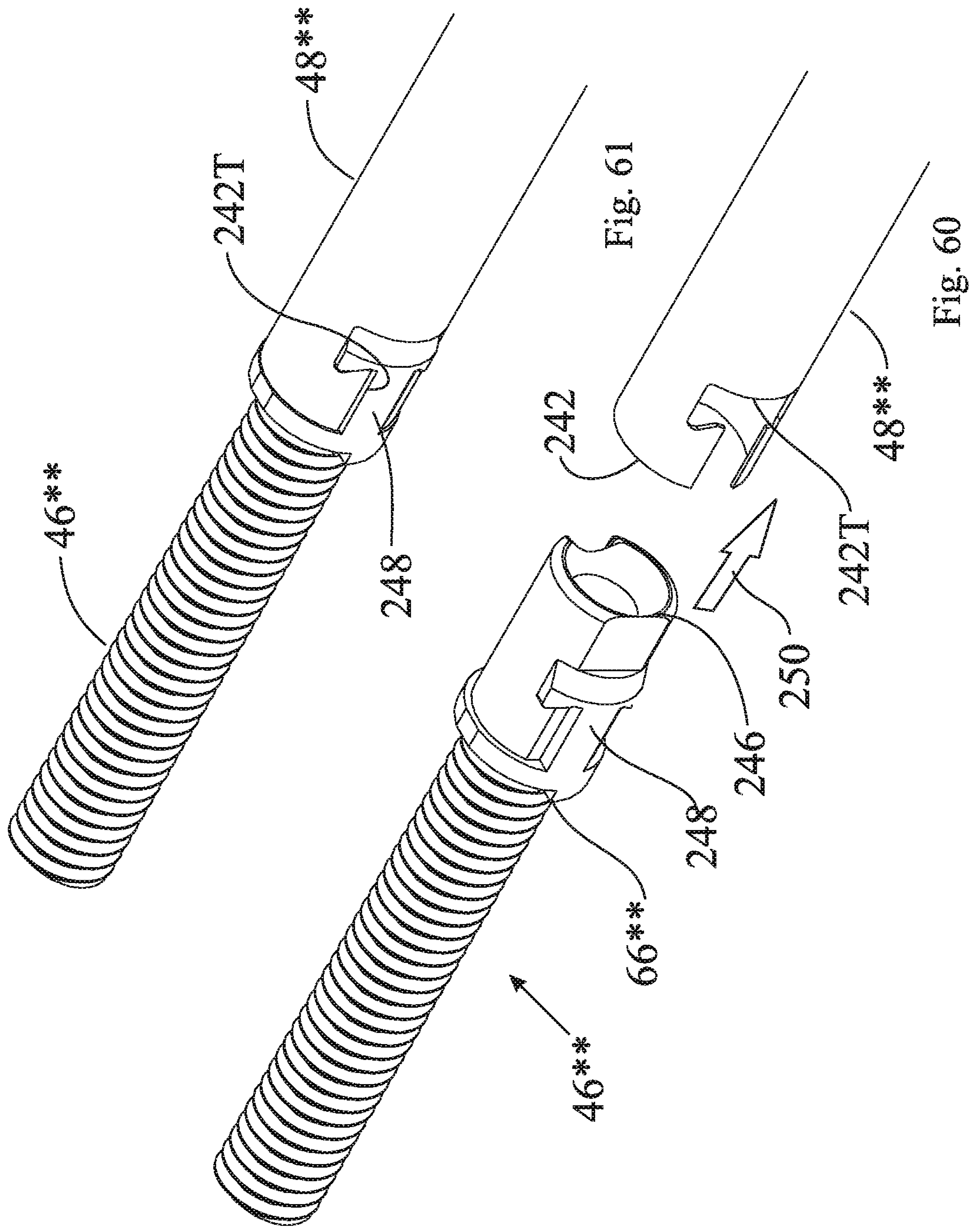


Fig. 61

Fig. 60

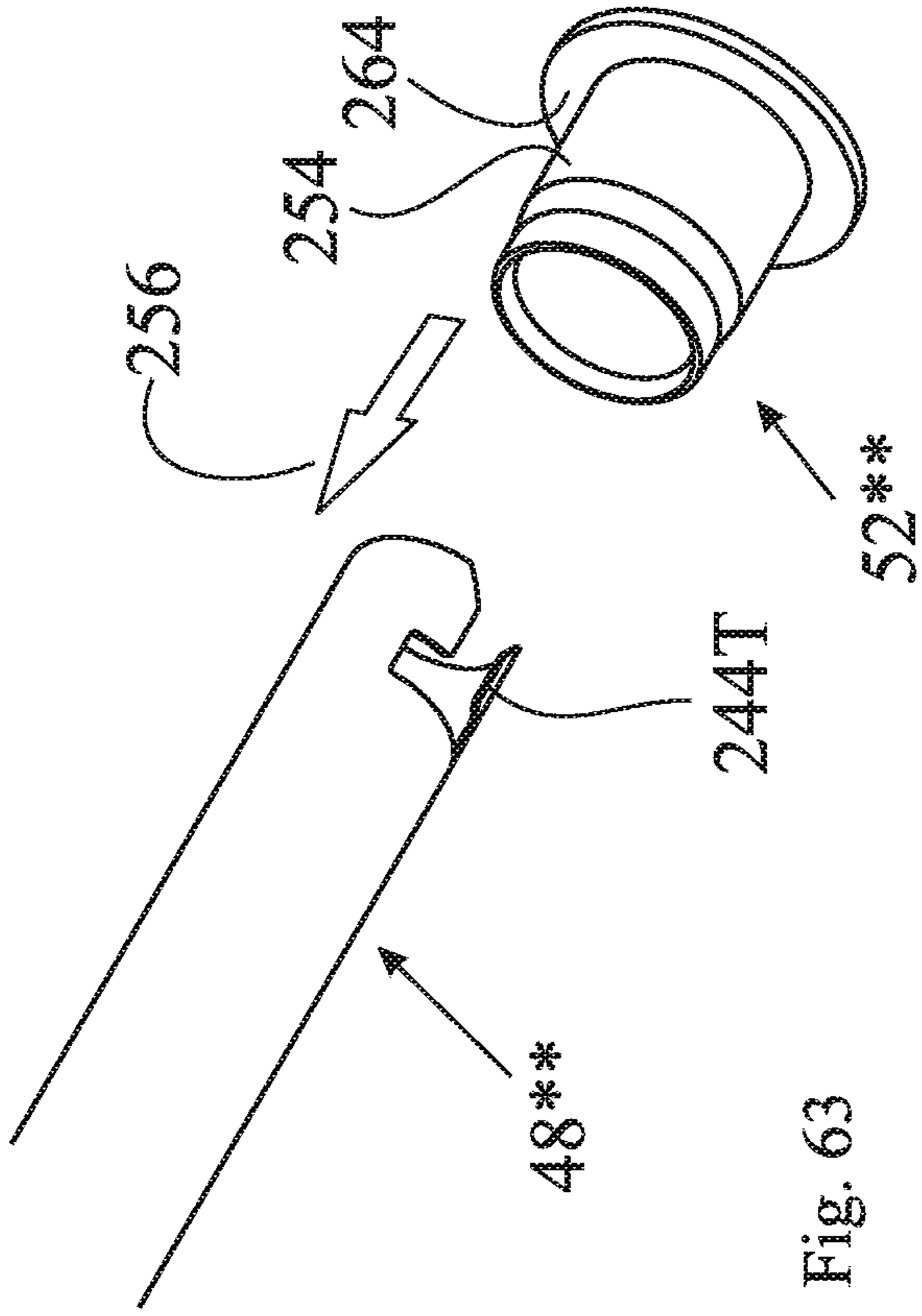


Fig. 63

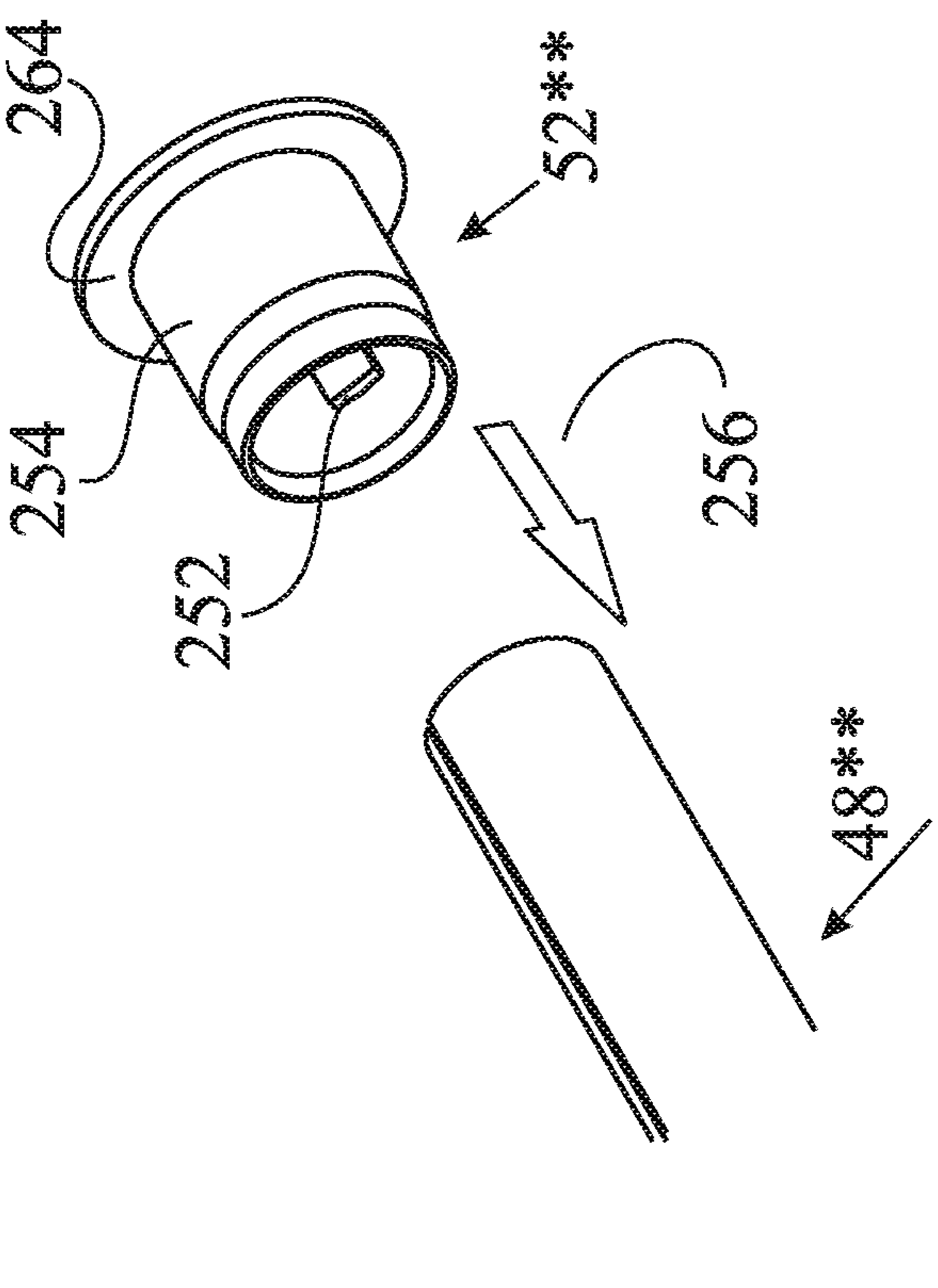


Fig. 62

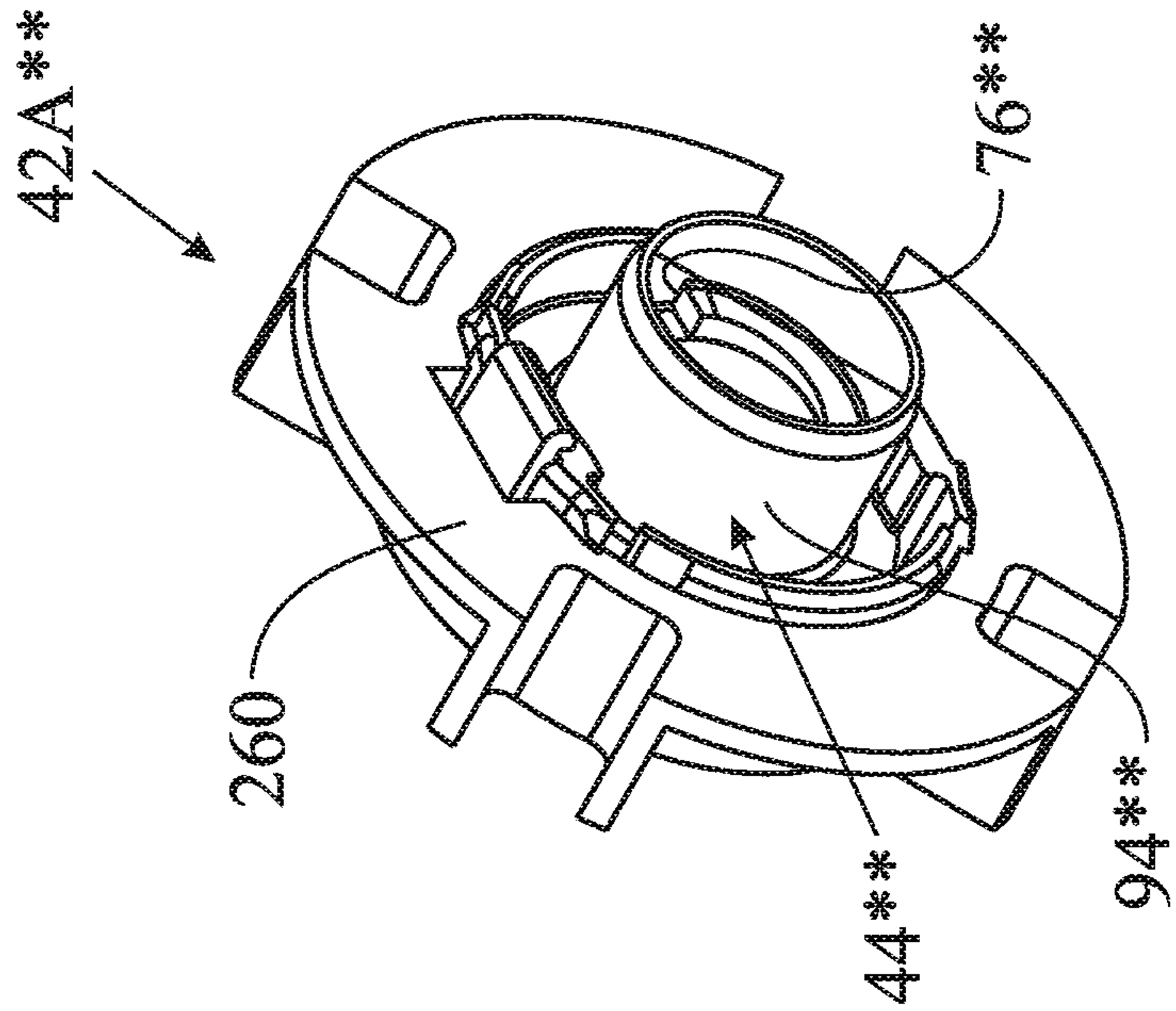


Fig. 65

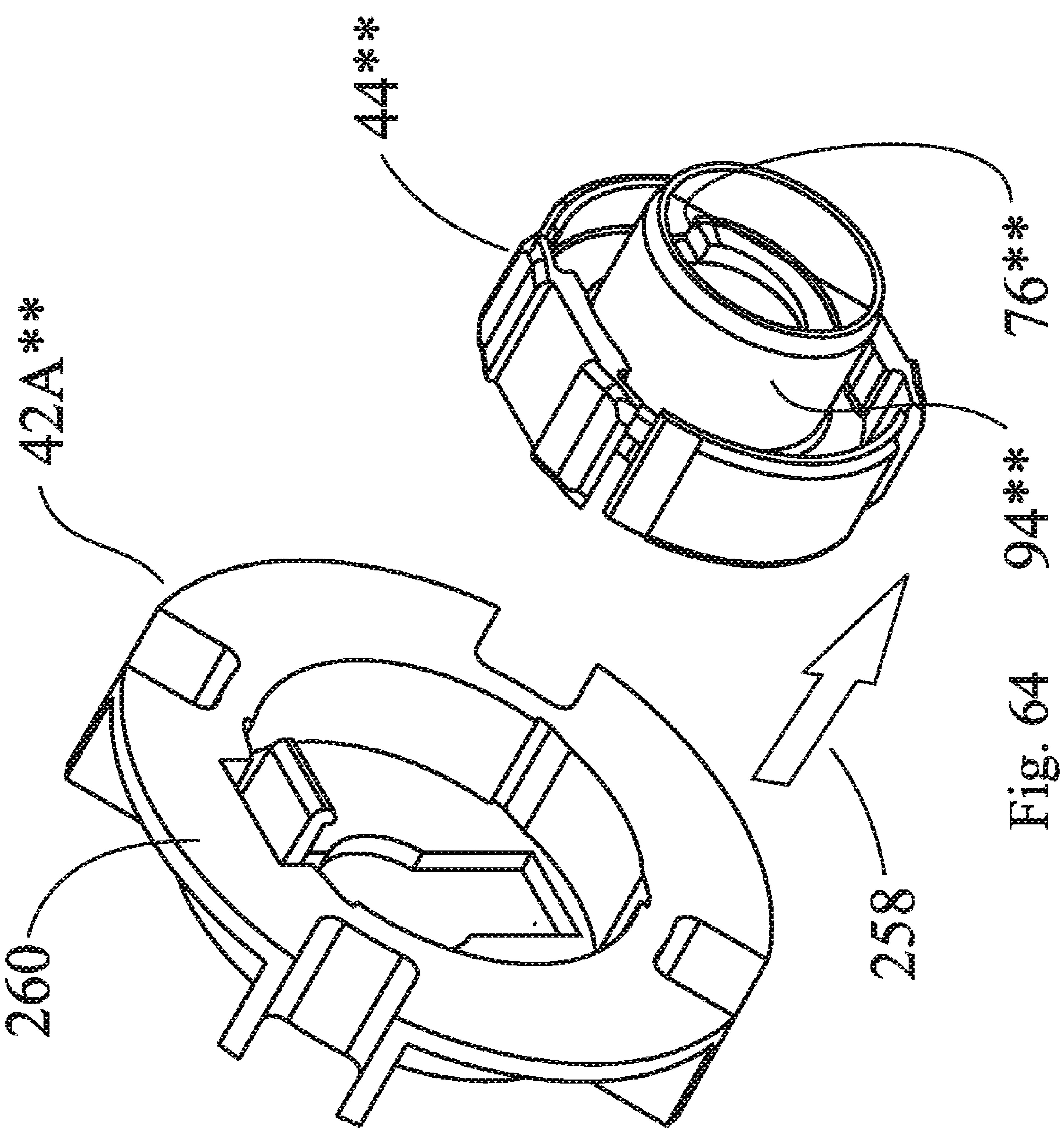


Fig. 64

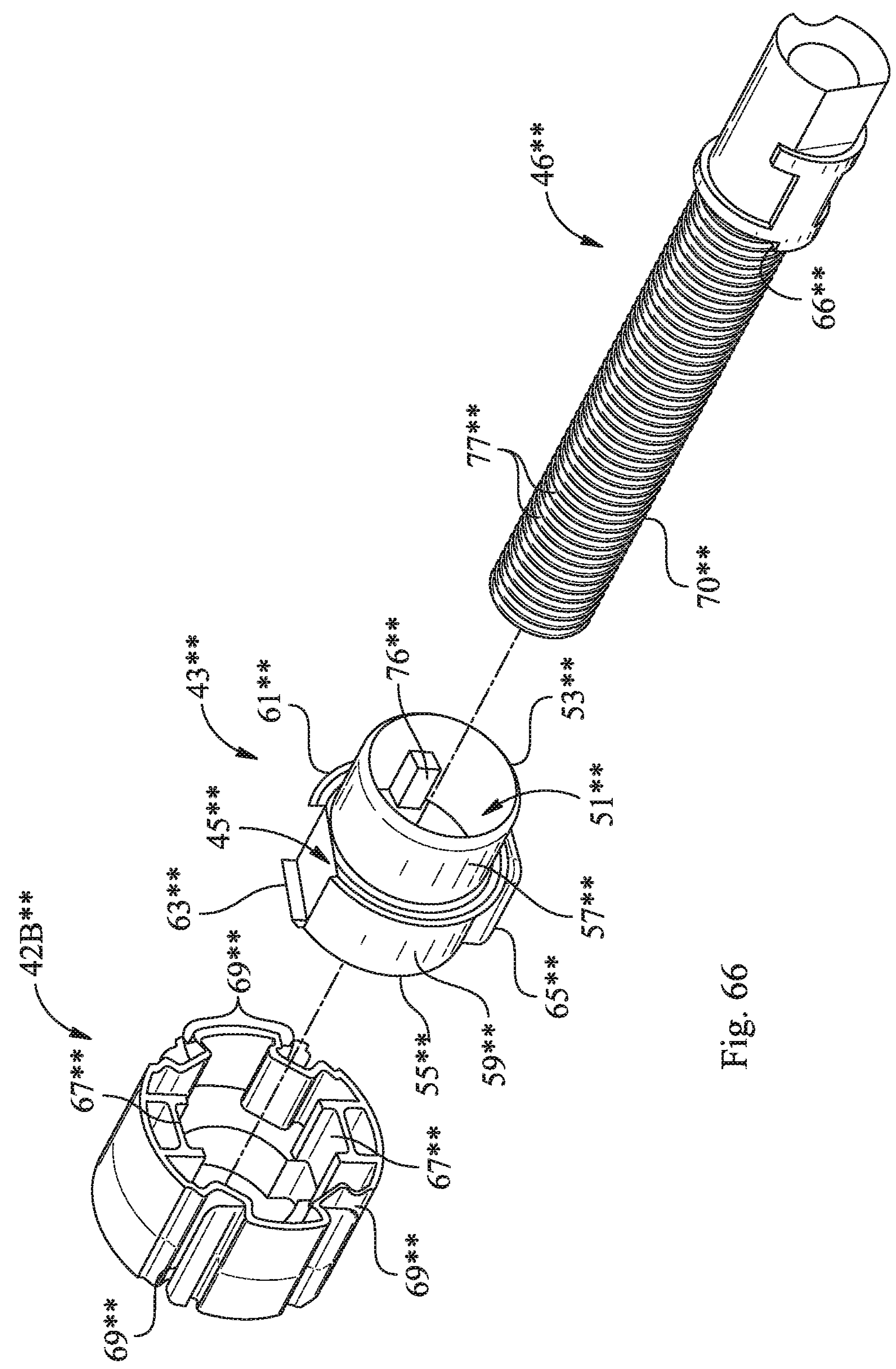


Fig. 66

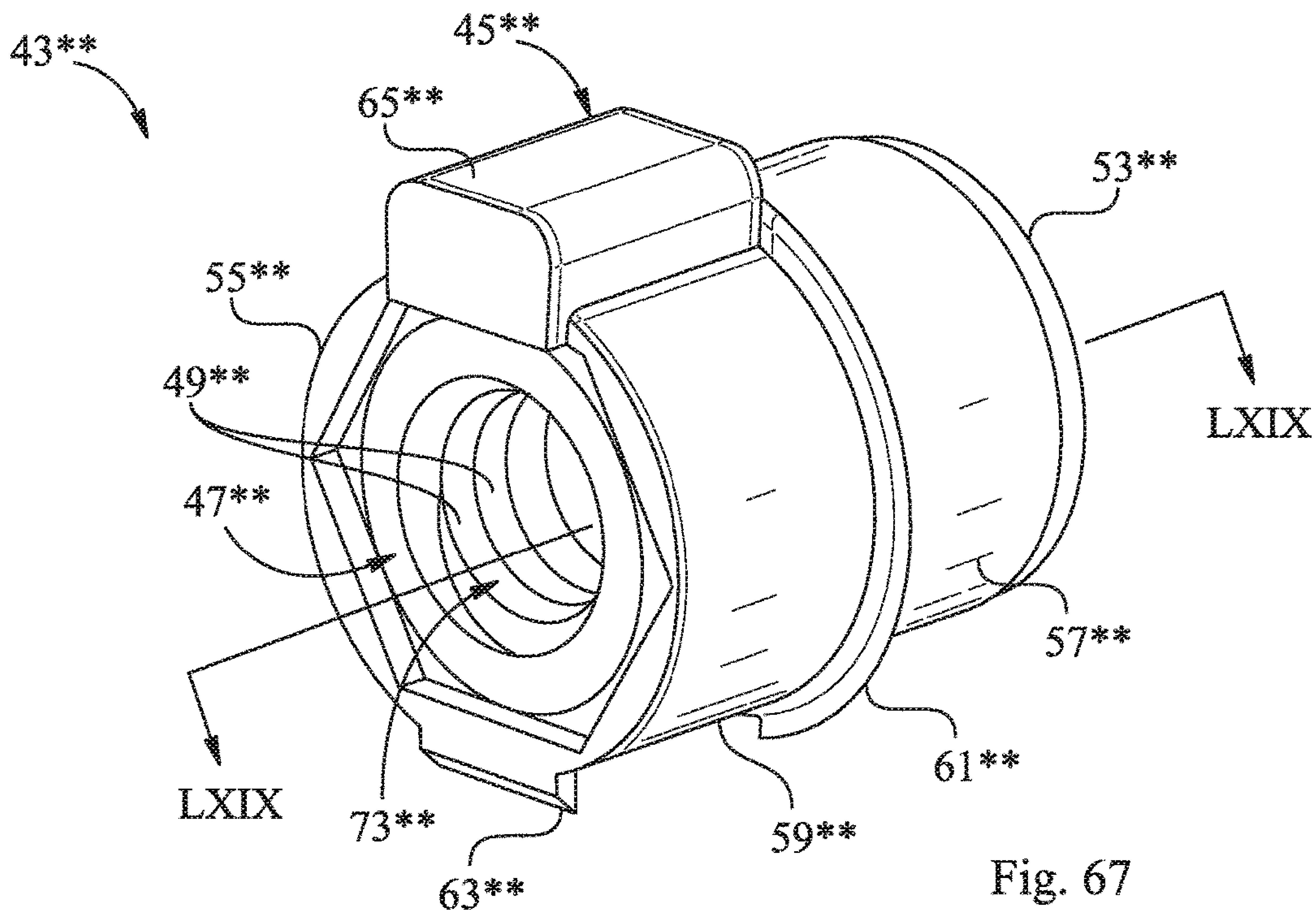

43**
45**
65**
53**
55**
49**
47**
LXIX
57**
61**
LXIX
73**
59**
63**

Fig. 67

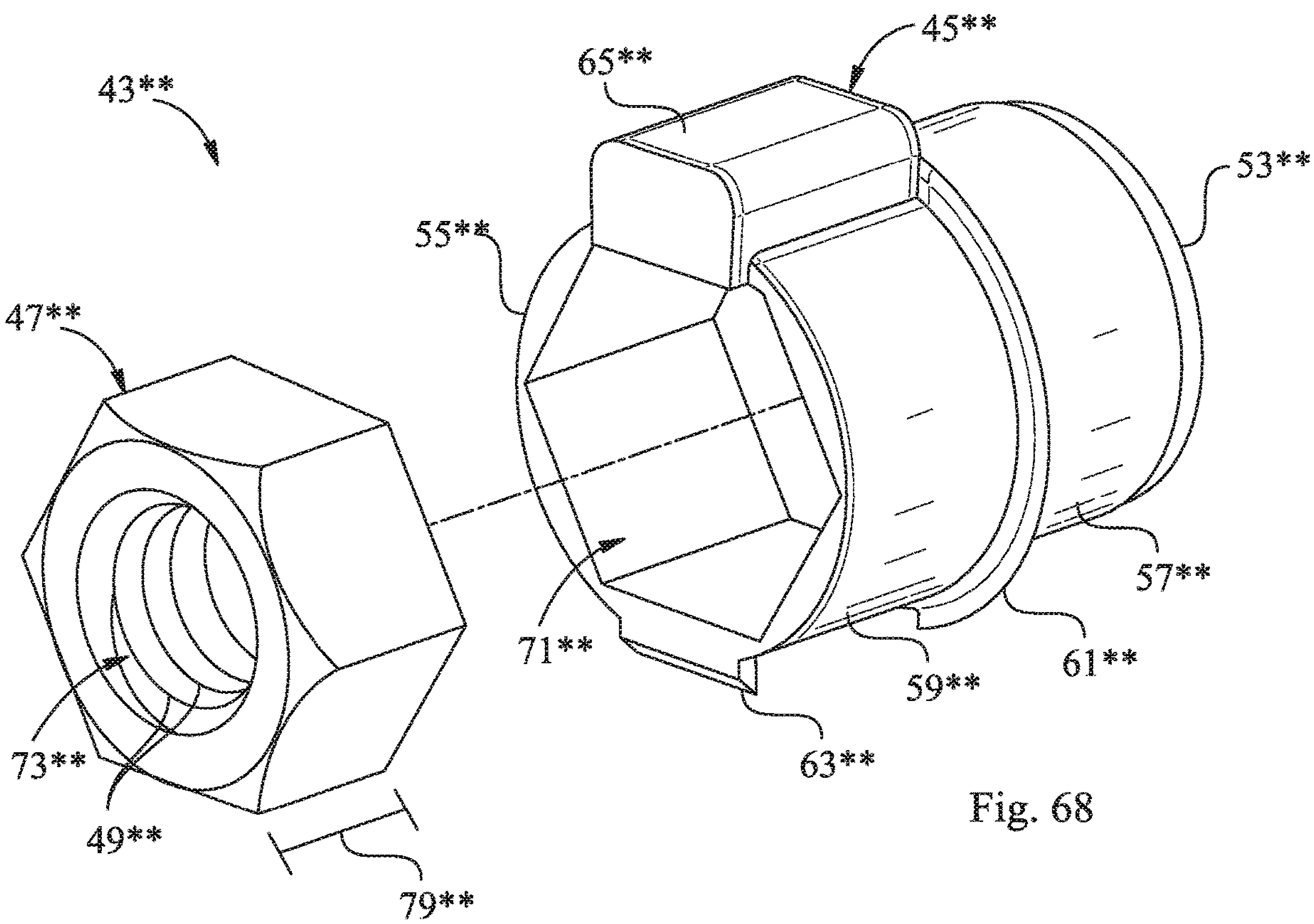

45**
65**
43**
53**
55**
47**
71**
57**
61**
59**
73**
63**
49**
79**

Fig. 68

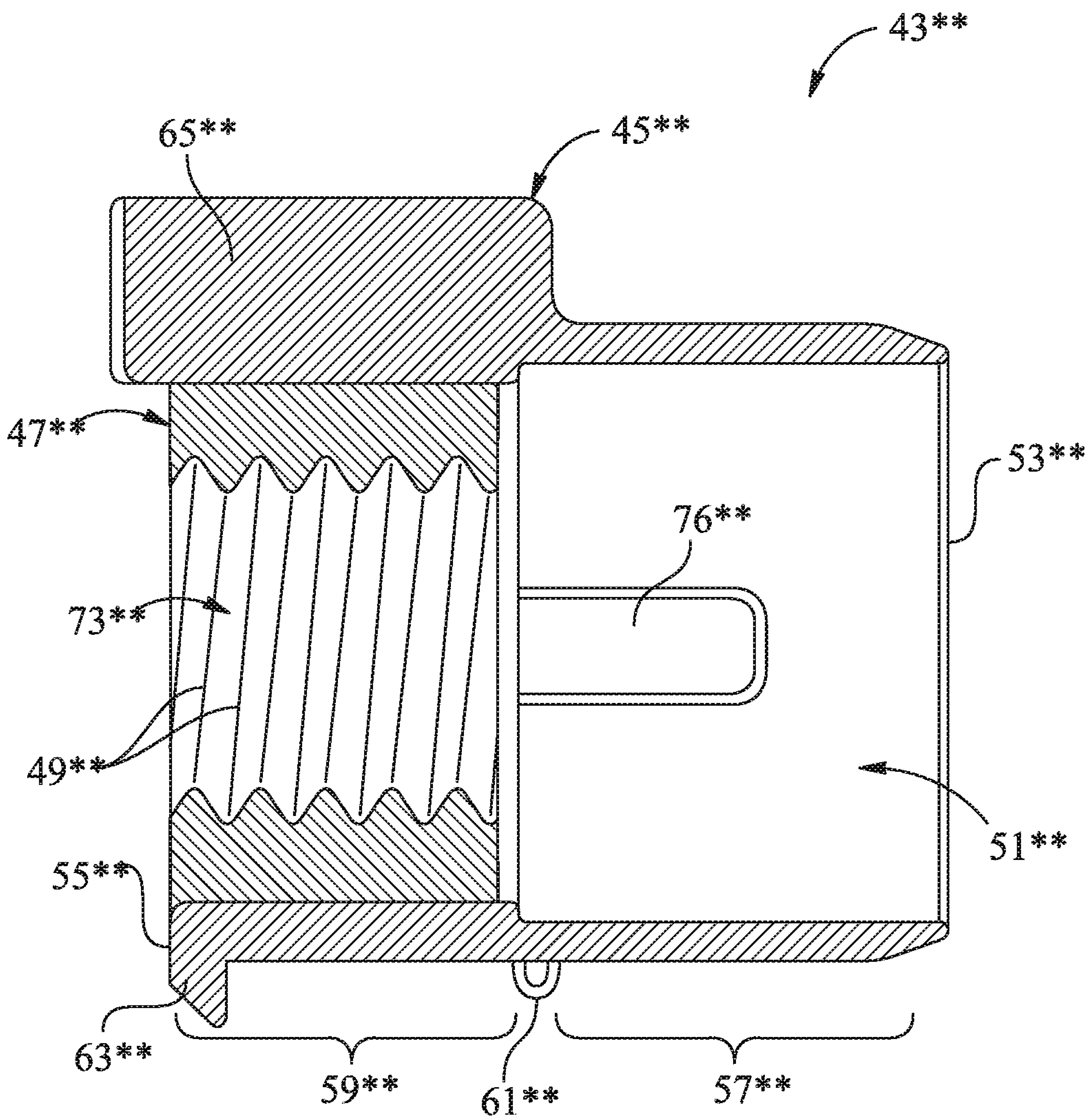
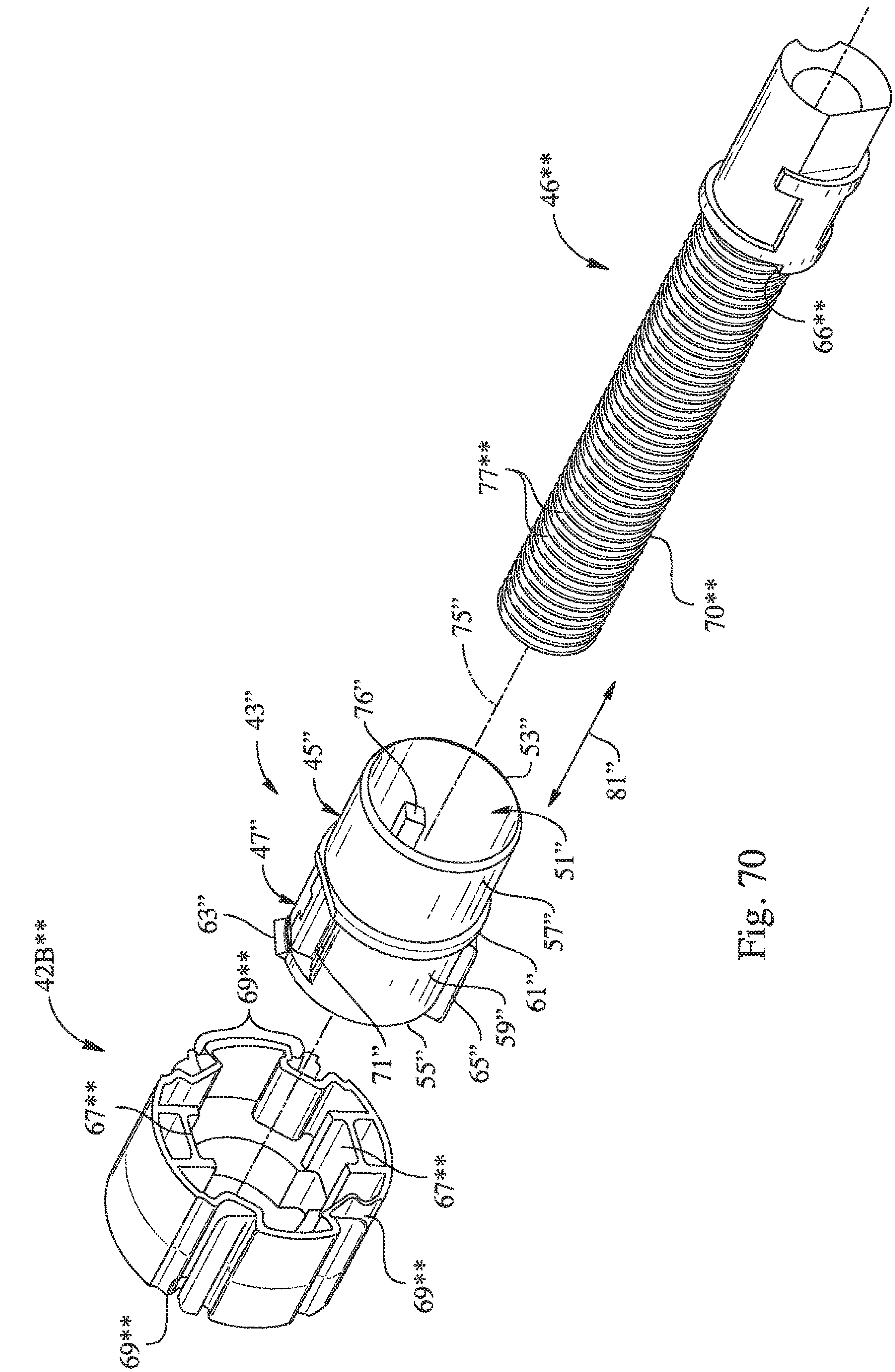


Fig. 69



46**
66**
77**
70**
75"
76"
43"
45"
53"
81"
47"
51"
63"
57"
42B**
69**
61"
59"
71"
55"
65"
67**
67**
69**
69**

Fig. 70

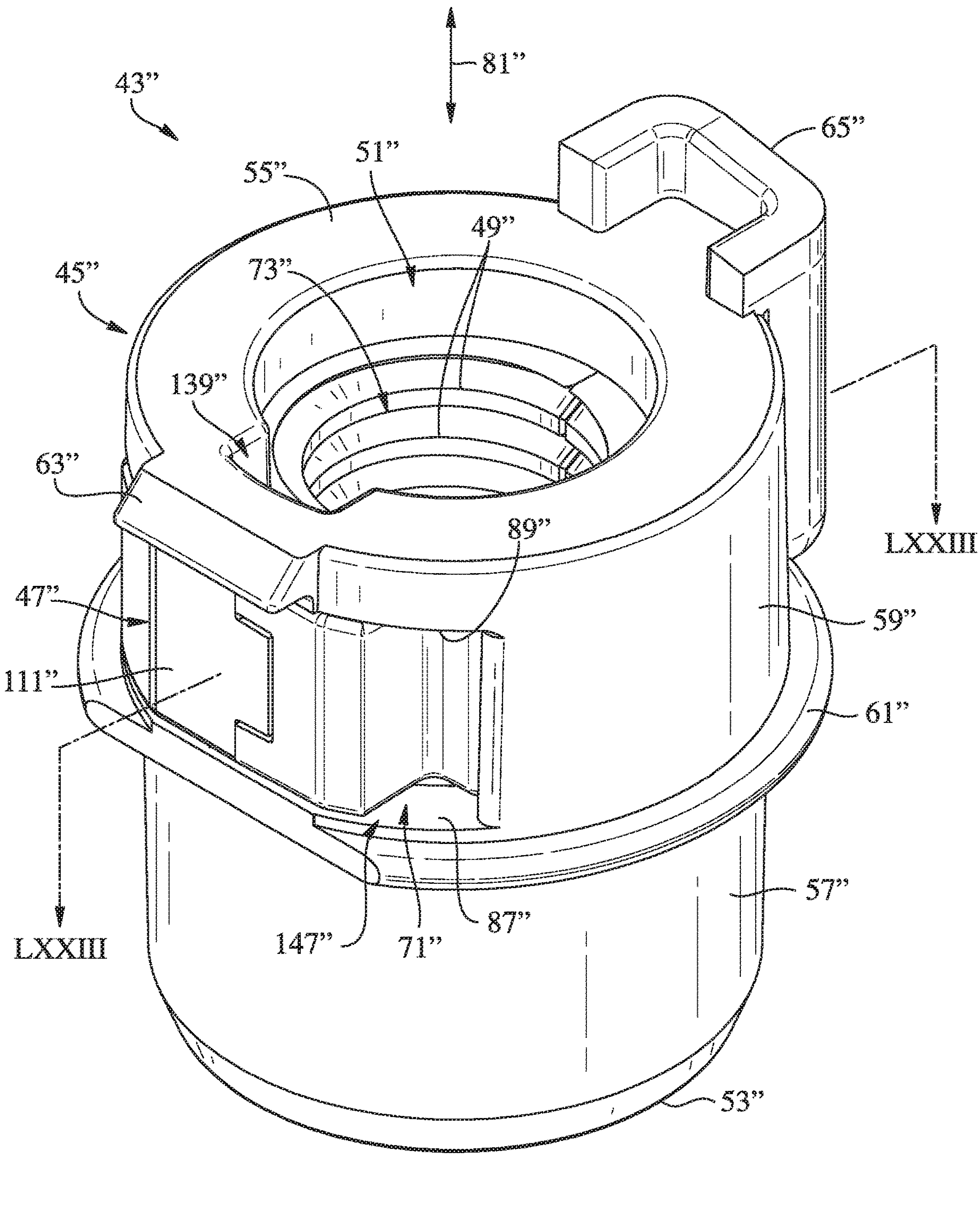

81"
43"
65"
51"
55"
49"
73"
45"
139"
63"
89"
LXXIII
47"
59"
111"
61"
57"
LXXIII
147"
71"
87"
53"

Fig. 71

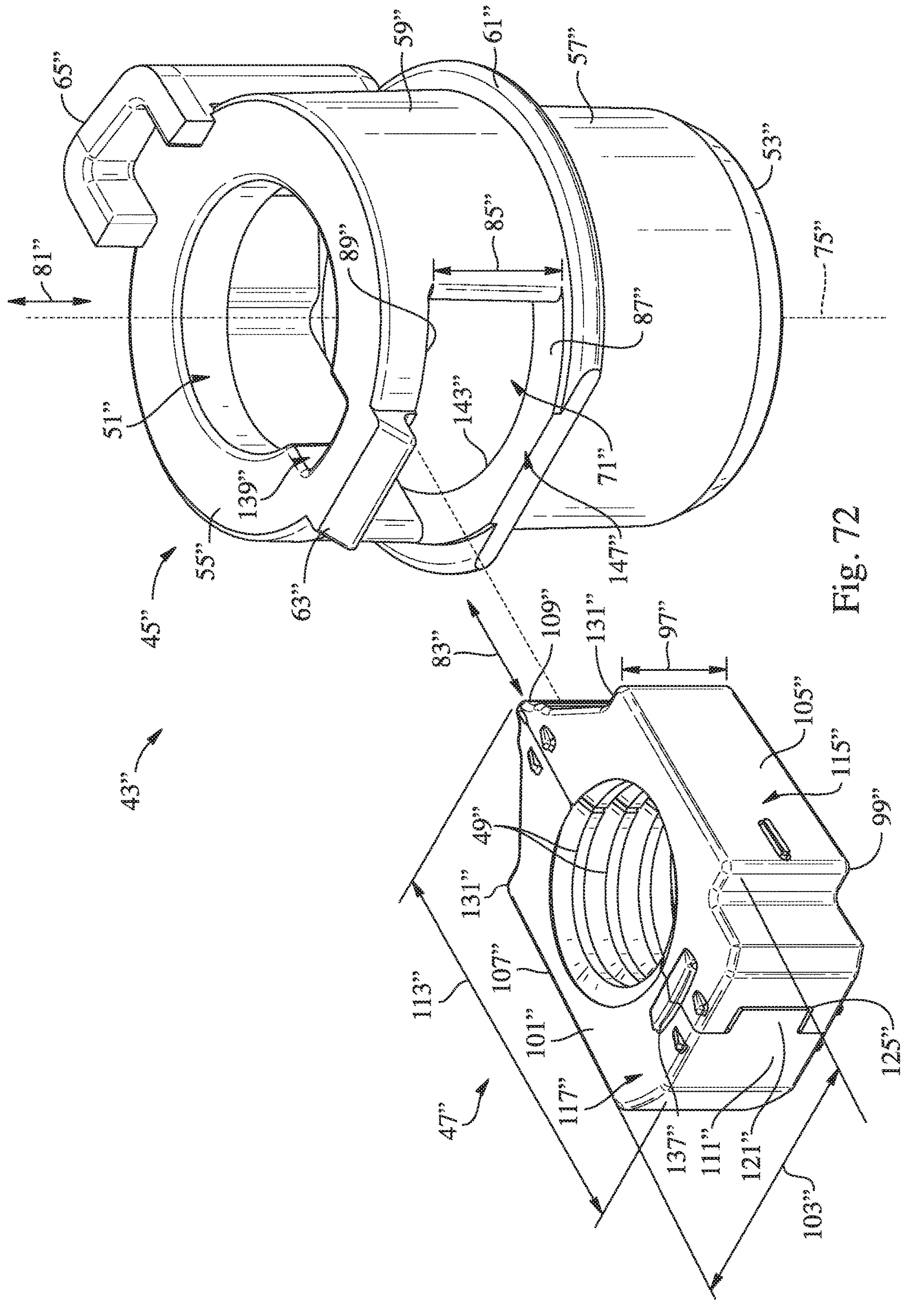
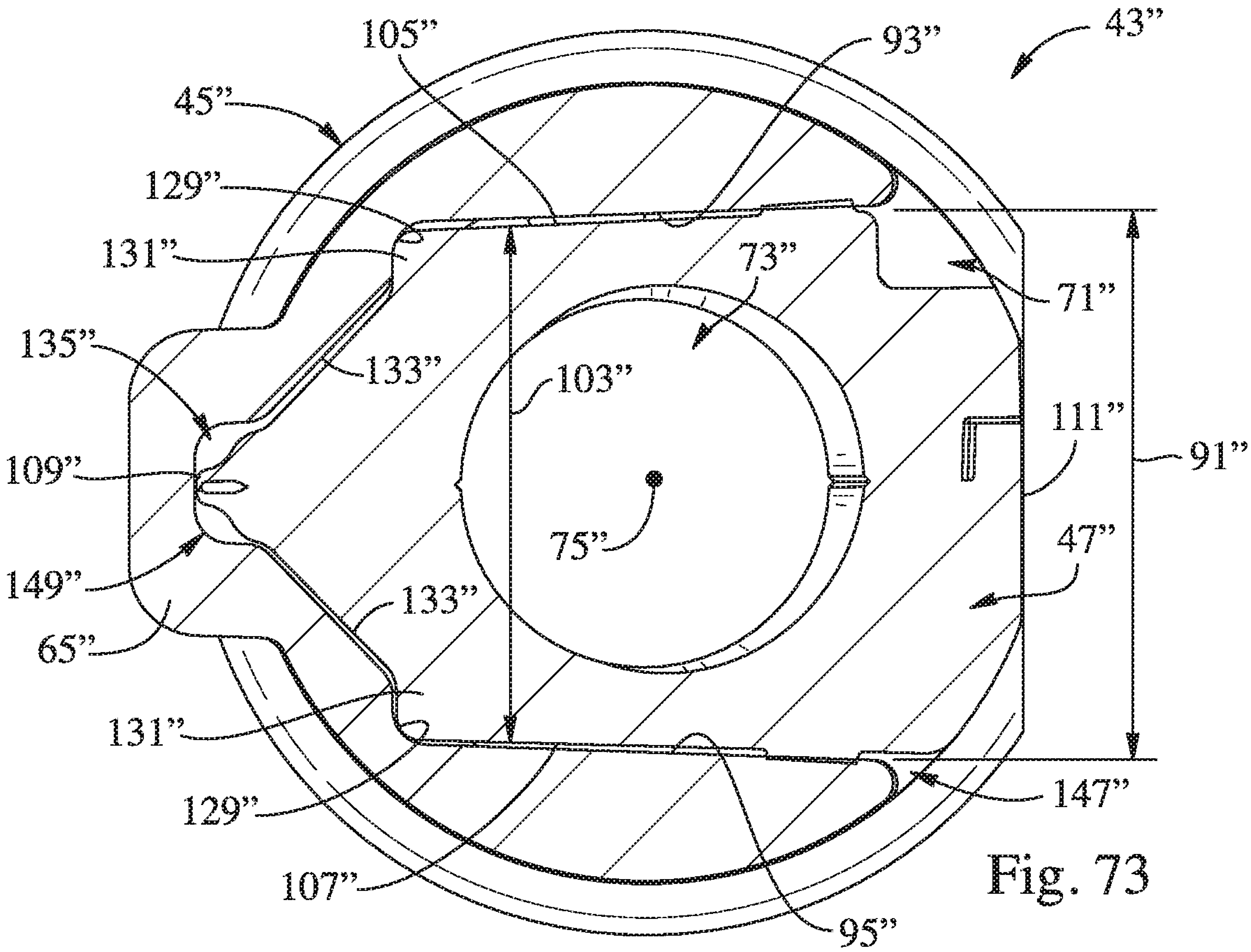
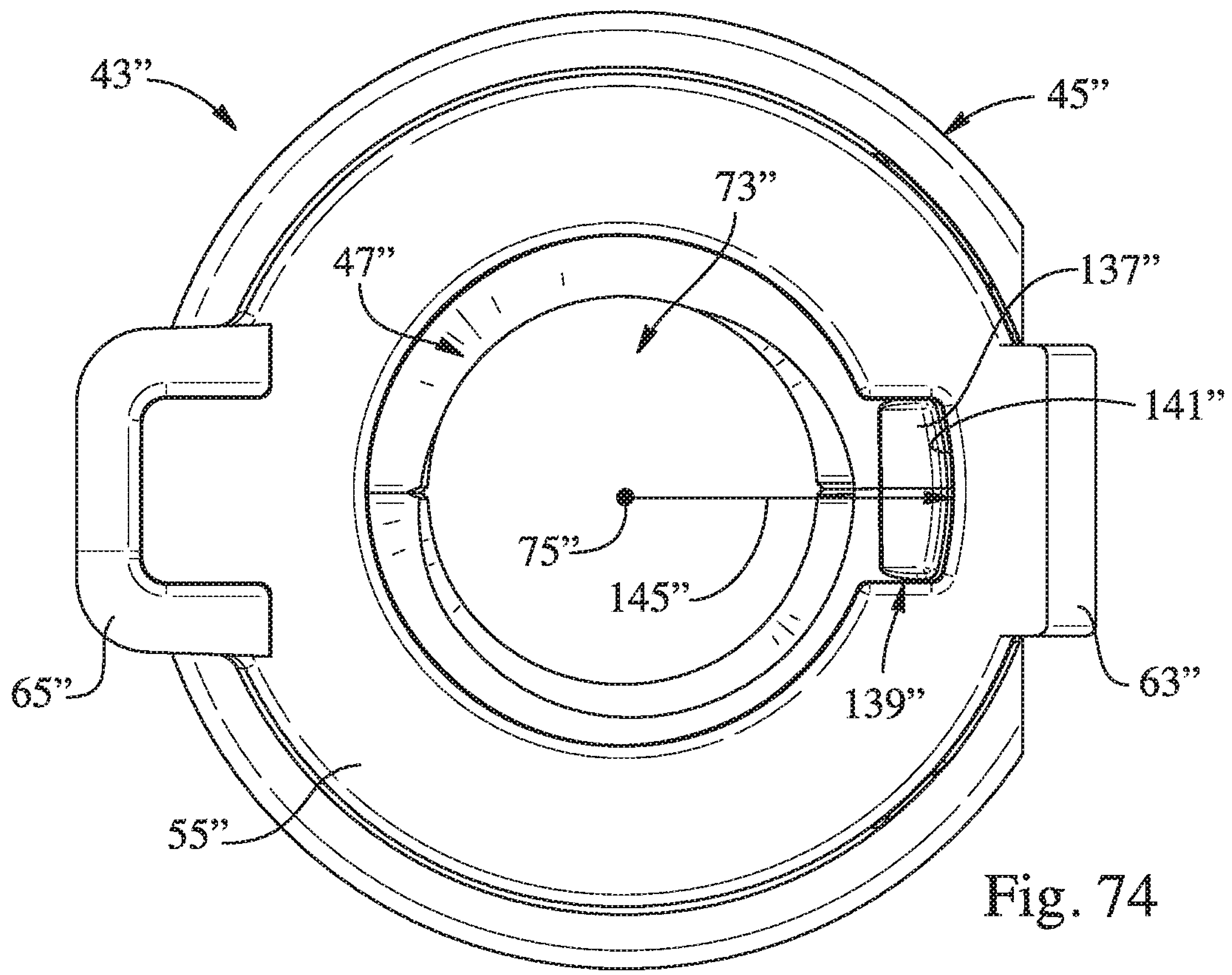

65"
59"
61"
57"
53"
75"
81"
85"
89"
87"
51"
143"
71"
139"
147"
55"
63"
45"
43"
83"
109"
131"
97"
105"
115"
99"
49"
131"
107"
113"
101"
117"
47"
137"
111"
121"
103"
125"

Fig. 72



43"
105"
93"
45"
129"
73"
131"
71"
135"
133"
103"
111"
91"
109"
75"
47"
149"
133"
65"
131"
147"
129"
107"
95"

Fig. 73



43"
45"
73"
47"
137"
141"
75"
145"
65"
139"
63"
55"

Fig. 74

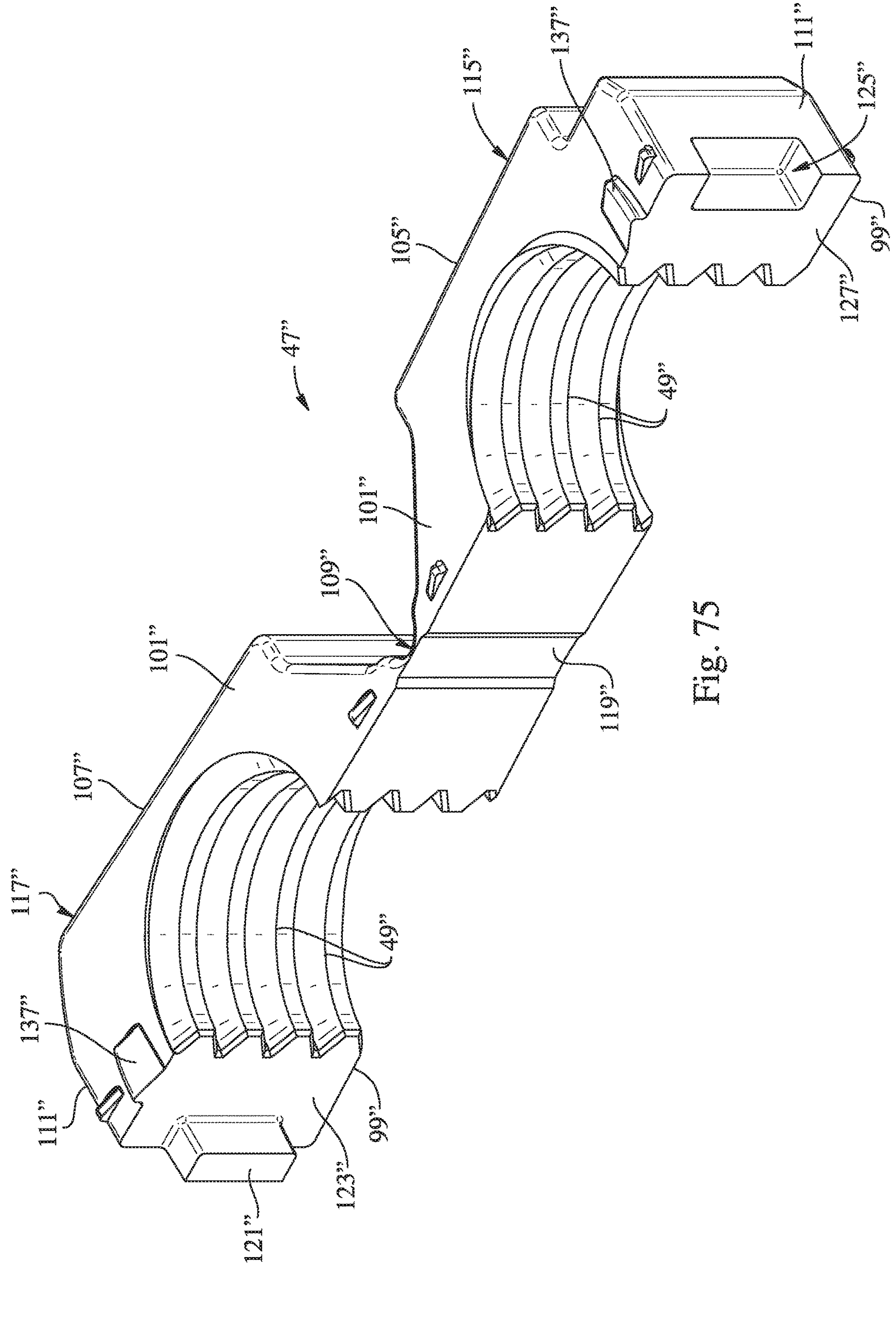

115”
137”
111”
125”
105”
99”
127”
47”
49”
101”
109”
101”
107”
119”
117”
49”
137”
111”
99”
123”
121”

Fig. 75

POWER ASSIST MODULE FOR COVERINGS FOR ARCHITECTURAL STRUCTURES AND RELATED DRIVE PLUG ASSEMBLIES

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application is based upon and claims the right of priority to U.S. Provisional Patent Application No. 62/771,669, filed Nov. 27, 2018, the disclosure of which is hereby incorporated by reference herein in its entirety for all purposes.

FIELD OF THE INVENTION

The present subject matter relates generally to coverings for architectural structures and, more particularly, to a power assist module for a covering that provides enhanced performance and improved durability, as well as increased ease of assembly when assembling the components of the power assist module.

BACKGROUND OF THE INVENTION

In a top down roller shade, the entire light blocking material typically wraps around a rotator rail (also referred to as a rotator tube or roller tube) as the shade is raised or retracted. Therefore, the weight of the shade is transferred to the rotator rail as the shade is raised, and the force required to raise the shade is thus progressively lower as the shade (the light blocking element) approaches the fully raised (fully open or retracted) position. Of course, there are also bottom up shades and composite shades which are able to do both, to go top down and/or bottom up. In the case of a bottom/up shade, the weight of the shade is transferred to the rotator rail as the shade is lowered, mimicking the weight operating pattern of a top/down blind.

A wide variety of drive mechanisms are known for extending and retracting coverings—moving the coverings vertically or horizontally or tilting slats. A number of these drive mechanisms may use a spring motor or power assist module to provide the catalyst force (and/or to supplement the operator supplied catalyst force) to move the coverings. For instance, various examples of power assist modules are disclosed in U.S. Pat. No. 9,080,381 (hereinafter the "381 patent"), entitled "Power Assist Module for Roller Shades." the disclosure of which is hereby incorporated by reference herein in its entirety for all purposes. In general, the '381 patent discloses power assist modules that can be pre-wound and that retain their pre-wound condition even when removed from the associated roller tube or rotator rail.

While the power assist modules of the '381 patent exhibit significant advantages over similar modules and related systems within the marketplace, a need still exists for further refinements and improvements to such power assist modules. Accordingly, an improved power assist module for a covering for an architectural structure would be welcomed in the technology.

BRIEF DESCRIPTION OF THE INVENTION

Aspects and advantages of the present subject matter will be set forth in part in the following description, or may be obvious from the description, or may be learned through practice of the present subject matter.

In various aspects, the present subject matter is directed to a power assist module for a covering for an architectural structure. In general, the power assist module includes a spring and a spring shaft extending through the spring. Additionally, the power assist module includes a threaded shaft member coupled to the spring shaft and a drive plug assembly coupled to the threaded shaft member for rotation relative thereto. The drive plug assembly includes a follower member and a separate threaded insert configured to be received within the follower member. The threaded insert is configured to threadably engage the threaded shaft member to allow the follower member to be rotationally coupled to the threaded shaft member in a manner that allows the follower member to move axially along the threaded shaft member as the follower member is rotated relative to the threaded shaft member.

Moreover, in several embodiments, the follower member defines an insertion channel for installing the threaded insert within the follower member. In one embodiment, the insertion channel provides access to an interior shaft opening of the follower member in a direction transverse to the axial direction of the drive plug assembly. In such an embodiment, the threaded insert is configured to be inserted through the insertion channel in the transverse direction to allow the threaded insert to be at least partially received within the shaft opening of the follower member. The threaded insert can then threadably engage the threaded shaft member when the shaft member is installed through the shaft opening.

Additionally, the present subject matter is also directed to a drive plug assembly configured for use with a threaded shaft. The drive plug assembly includes a follower member and a separate threaded insert configured to be received within the follower member. The threaded insert is configured to threadably engage the threaded shaft to allow the follower member to be rotationally coupled to the threaded shaft in a manner that allows the follower member to move axially along the threaded shaft as the follower member is rotated relative to the threaded shaft.

These and other features, aspects and advantages of the present subject matter will become better understood with reference to the following Detailed Description and appended claims. The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the present subject matter and, together with the description, serve to explain the principles of the present subject matter.

This Brief Description is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Brief Description is not intended to identify key features or essential features of the claimed subject matter, nor is it intended as an aid in determining the scope of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

A full and enabling disclosure of the present subject matter, including the best mode thereof, directed to one of ordinary skill in the art, is set forth in the specification, which makes reference to the appended figures, in which:

FIG. **1** illustrates a perspective view of one embodiment of a roller shade including a control mechanism for extending and retracting the shade in accordance with aspects of the present subject matter;

FIG. **2** illustrates a partially exploded perspective view of the roller shade of FIG. **1**, with the control mechanism omitted for clarity;

FIG. **3** illustrates a partially exploded perspective view of the roller shade of FIG. **2**;

FIG. **4** illustrates a perspective view of one of the power assist modules of FIG. **3**:

FIG. **5** illustrates an exploded perspective view of the power assist module of FIG. **4**;

FIG. **6** illustrates a side view of the roller shade of FIG. **1**, with the rotator rail and the control mechanism omitted for clarity;

FIG. **7**A illustrates a view along line **7**A-**7**A of FIG. **6**;

FIG. **7**B illustrates a view along line **7**B-**7**B of FIG. **6**;

FIG. **7**C illustrates a view along line **7**C-**7**C of FIG. **6**;

FIG. **8** illustrates an enlarged view of the right end portion of FIG. **7**A:

FIG. **9** illustrates an exploded perspective view of the drive plug shaft, the drive plug, and the limiter of the power assist module of FIG. **5**;

FIG. **10** illustrates is a partially broken away, perspective view of a preliminary assembly step of the drive plug shaft, the drive plug, and the limiter of FIG. **9**, also including the spring shaft;

FIGS. **11**, **12**, and **13** illustrates partially broken away, perspective views of progressive assembly steps of the spring to the drive plug of FIG. **10**;

FIG. **14** illustrates a partially broken away, perspective view of the step for locking the drive plug to the drive plug shaft once the desired degree of "pre-wind" has been added to the power assist module;

FIG. **15** illustrates a partially broken away, perspective end view of the rotator rail of FIGS. **1** and **2**.

FIG. **16** illustrates a perspective view of another embodiment of a roller shade including a control mechanism for extending and retracting the shade in accordance with aspects of the present subject matter;

FIG. **17** illustrates a partially exploded perspective view of the roller shade of FIG. **16**;

FIG. **18** illustrates a partially exploded perspective view of the roller shade of FIG. **17**;

FIG. **19** illustrates a perspective view of one of the power assist modules of FIG. **18**;

FIG. **20** illustrates an exploded perspective view of the power assist module of FIG. **19**;

FIG. **21** illustrates a side view of the roller shade of FIG. **16**, with the rotator rail and the control mechanism omitted for clarity;

FIG. **22** illustrates a view along line **22**-**22** of FIG. **21**:

FIG. **23** illustrates an enlarged view of the right end portion of FIG. **22**;

FIG. **24** illustrates a view along line **24**-**24** of FIG. **21**;

FIG. **25** illustrates a view along line **25**-**25** of FIG. **21**;

FIG. **26** illustrates a view along line **26**-**26** of FIG. **21**;

FIG. **27** illustrates an exploded perspective view of the drive plug shaft, the drive plug, and the limiter of the power assist module of FIG. **20**;

FIG. **28** illustrates a partially broken away, perspective view of a preliminary assembly step of the drive plug shaft, the drive plug, and the limiter of FIG. **9**, also including the spring shaft;

FIG. **29** illustrates a partially broken away, perspective view of the step for locking the drive plug to the drive plug shaft once the desired degree of "pre-wind" has been added to the power assist module;

FIG. **30**A illustrates an assembled, perspective view of the spring plug and rotator rail adaptor;

FIG. **30**B illustrates an exploded, perspective view of the spring plug and rotator rail adaptor of FIG. **30**A;

FIG. **30**C illustrates a partially broken away, section view along line **30**C-**30**C of FIG. **30**A, showing the spring plug and rotator rail adaptor assembled onto a spring shaft;

FIG. **31** illustrates a section view, similar to FIG. **30**, but with an additional rotator rail adaptor ready to snap onto the existing rotator rail adaptor;

FIG. **32** illustrates a section view, similar to FIG. **31** but showing the additional rotator rail adaptor snapped onto the existing rotator rail adaptor;

FIG. **33** illustrates an end view of the rotator rail adaptor of FIG. **30** showing how it engages a 1" diameter rotator rail:

FIG. **34** illustrates an end view of the rotator rail adaptor of FIG. **30** showing how it engages a 1-½" diameter rotator rail;

FIG. **35** illustrates an end view of the rotator rail adaptors of FIG. **32** showing how the additional rotator rail adaptor engages a 2" diameter rotator rail:

FIG. **36** illustrates a perspective view of the drive plug, the limiter, and the spring shaft, similar to FIG. **28**, but shown from the opposite side, detailing the location for impacting the limiter to swage the spring shaft to the limiter:

FIG. **37** illustrates a section view along line **37**-**37** of FIG. **36**, prior to swaging the spring shaft to the limiter;

FIG. **38** illustrates a section view identical to that of FIG. **37**, but immediately after impacting a punch to the spring shaft so as to swage the spring shaft to the limiter;

FIG. **39** illustrates a section view, similar to that of FIG. **23**, but for another embodiment of a roller shade, wherein the rod is secured for non-rotation to the control mechanism for extending and retracting the shade, instead of being secured to the non-drive end mounting clip in accordance with aspects of the present subject matter:

FIG. **40** illustrates an assembled, perspective view of the control mechanism and the coupler with screw of FIG. **39**;

FIG. **41** illustrates a partially exploded, perspective view of the control mechanism and the coupler with screw of FIG. **40**;

FIG. **42** illustrates a perspective view, similar to that of FIG. **19**, but for another embodiment of a power assist module which incorporates both a top limiter and a bottom limiter;

FIG. **43** illustrates an exploded, perspective view of the power assist module of FIG. **42**;

FIG. **44** illustrates a perspective view of the top limiter portion of the power assist module of FIG. **43**;

FIG. **45** illustrates an opposite-end perspective view of the top limiter portion of the power assist module of FIG. **43**;

FIG. **46**A illustrates an exploded, perspective view of the limiters portion of the power assist module of FIG. **43**;

FIG. **46**B illustrates a perspective view of the assembled components of FIG. **46**A, also including a view of an idle end mounting adapter assembly for securing the rod to an end bracket:

FIG. **47** illustrates a perspective view of the locking ring and locking nut portion of the bottom limiter portion of FIG. **46**, during a first step of adjusting the bottom stop:

FIG. **48** illustrates a perspective view of the locking ring and locking nut portion of the bottom limiter portion of FIG. **46**, during a second step of adjusting the bottom stop;

FIG. **49** illustrates a perspective view of the locking ring and locking nut portion of the bottom limiter portion of FIG. **46**, during a final step of adjusting the bottom stop:

FIG. **50** illustrates a perspective view similar to that of FIG. **42**, but of another embodiment of a power assist module which incorporates both a top limiter and an infinitely adjustable bottom limiter in accordance with aspects of the present subject matter;

FIG. **51** illustrates an exploded, perspective view of the infinitely adjustable portion of the bottom stop limiter of FIG. **50**;

FIG. **52** illustrates an exploded, perspective view of the bracket clip assembly of FIG. **51**;

FIG. **53** illustrates a section view along line **53-53** of FIG. **50**, with the clutch mechanism in the locked position

FIG. **54** illustrates a section view, similar to that of FIG. **53**, but with the clutch mechanism allowing slippage of the clutch input so as to raise the hem of the shade;

FIG. **55** illustrates a section view, similar to that of FIG. **53**, but with the clutch mechanism allowing slippage of the clutch input so as to lower the hem of the shade;

FIG. **56** illustrates a broken away, perspective view of a reverse shade with the stop of FIG. **50** being adjusted to raise or lower the bottom hem of the shade:

FIG. **57** illustrates a broken away, partially exploded, perspective view of the shade of FIG. **56**:

FIG. **58** illustrates a broken away, partially exploded perspective view of the shade of FIG. **56**;

FIG. **59** illustrates an exploded perspective view of another embodiment of a power assist module in accordance with aspects of the present subject matter;

FIG. **60** illustrates a broken away, exploded perspective view of the limiter and the spring shaft of FIG. **59**:

FIG. **61** illustrates broken away, assembled view of the limiter and the spring shaft of FIG. **60**;

FIG. **62** illustrates a broken away, exploded perspective view of the spring shaft and the spring plug of FIG. **59**:

FIG. **63** illustrates the same view as FIG. **62** but from a different angle;

FIG. **64** illustrates an exploded perspective view of the roller tube adapter and the combination drive plug/drive plug shaft of FIG. **59**;

FIG. **65** illustrates a perspective view of the assembled roller tube adapter and the combination drive plug/drive plug shaft of FIG. **64**;

FIG. **66** illustrates a perspective view of one embodiment of a drive plug assembly suitable for use within a power assist module in accordance with aspects of the present subject matter, particularly illustrating the drive plug assembly exploded away from a corresponding drive adapter and a limiter suitable for use within a power assist module;

FIG. **67** illustrates another perspective view of the drive plug assembly shown in FIG. **66**;

FIG. **68** illustrates an exploded, perspective view of the drive plug assembly shown in FIG. **67**:

FIG. **69** illustrates a cross-sectional view of the drive plug assembly shown in FIG. **67** taken about line LXIX-LXIX:

FIG. **70** illustrates a perspective view of another embodiment of a drive plug assembly suitable for use within a power assist module in accordance with aspects of the present subject matter, particularly illustrating the drive plug assembly exploded away from a corresponding drive adapter and a limiter suitable for use within a power assist module:

FIG. **71** illustrates another perspective view of the drive plug assembly shown in FIG. **70**:

FIG. **72** illustrates an exploded, perspective view of the drive plug assembly shown in FIG. **70**:

FIG. **73** illustrates a cross-sectional view of the drive plug assembly shown in FIG. **71** taken about line LXXIII-LXXIII;

FIG. **74** illustrates an end view of the drive plug assembly shown in FIG. **71**; and

FIG. **75** illustrates a perspective view of a threaded insert of the drug plug assembly shown in FIG. **71**, particularly illustrating the threaded insert including hinged nut portions moved to an opened position.

DETAILED DESCRIPTION OF THE INVENTION

In general, the present subject matter is directed to a power assist module for a covering for an architectural feature or structure (referred to herein simply as architectural "structure" for the sake of convenience without intent to limit), such as a window or door. In several embodiments, the power assist module is configured to assist the covering in moving from an extended position to a retracted position. For instance, in one embodiment, the power assist module includes a spring configured to be wound up as the covering is moved towards the extended position to allow the spring to store energy. Thereafter, the spring is allowed to unwind or release its stored energy when it is desired to move the covering to the retracted position, thereby allowing the spring to assist in raising the covering.

In one embodiment, the power assist module also includes an elongated spring shaft configured to be received within the spring such that the spring surrounds at least a portion the spring shaft. In addition, the power assist module includes a threaded shaft member coupled to the spring shaft and a drive plug assembly configured to be coupled to the threaded shaft member for rotation relative thereto. In one embodiment, the drive plug assembly includes a follower member and a separate threaded insert configured to be received within the follower member. The threaded insert is configured to threadably engage the threaded shaft member within the follower member to allow the follower member to be rotationally coupled to the threaded shaft member in a manner that permits the follower member to move axially along the threaded shaft member as the follower member is rotated relative to the threaded shaft member.

In one embodiment, the threaded shaft member and the follower member define corresponding shoulders or mechanical stops configured to contact each other when the covering is moved to the fully retracted position. For instance, the threaded shaft member may include a first stop and the follower member may include a corresponding second stop. In such an embodiment, as the covering is being raised and the follower member is moving axially along the threaded shaft member as the follower member rotates relative to the threaded shaft member, the second stop may contact or abut against the first stop once the follower member has moved axially along the threaded shaft member a given or predetermined axial distance (e.g., corresponding to when the cover reaches its fully retracted position) to prevent further rotation of the follower member relative to threaded shaft member.

In one embodiment, the follower member defines a shaft opening in the axial direction of the drive plug assembly between opposed first and second axial ends of the follower member. In such an embodiment, the threaded shaft member is configured to be received within the shaft opening. For example, when the follower member is installed relative to the threaded shaft member, at least a portion of the threaded shaft member may extend axially through the shaft opening.

Additionally, in one embodiment, the follower member defines an insertion channel providing access to the shaft opening in a direction transverse to the axial direction (e.g., along a radial direction of the follower member). The threaded insert is configured to be inserted through the insertion channel along the transverse direction such that the insert is at least partially received within a portion of the shaft opening between the opposed first and second axial ends of the follower member. By installing the threaded insert within the follower member via the insertion channel, the threaded shaft member may be configured to threadably engage the threaded insert when the threaded shaft member is inserted through the shaft opening.

Moreover, in one embodiment, when the threaded insert is inserted through the insertion channel, the insert is retained axially within the follower member between opposed axial portions of the follower member positioned along either axial side of the insertion channel. Specifically, by defining the insertion channel along the outer perimeter of the follower member at a location between the axial ends of the follower member, opposed axial portions of the follower member (e.g., opposed axial retention walls) may be provided along each axial side of the insertion channel between which the threaded insert is axially trapped or retained. The axial positioning of the threaded insert relative to the follower member may then be fixed or otherwise maintained relatively constant during operation of the associated power assist module.

In one embodiment, the threaded insert and/or the insertion channel of the follower member is shaped, dimensioned, and/or otherwise configured such that the threaded insert is capable of being inserted through the insertion channel in only a given orientation. For instance, in one embodiment, the threaded insert and the insertion channel may be shaped and/or dimensioned such that the threaded insert can be inserted through the insertion channel only when a particular end or side of the insert is initially received within the channel for insertion therethrough.

By configuring the threaded insert to be installed within the follower member in only a specific orientation, the threads of the threaded insert can be properly clocked relative to the follower member to ensure that the desired stop position is obtained for the associated covering. For instance, the circumferential starting location for the internal threads of the threaded insert at each axial end or end face of the insert may be selected such that, when the insert is installed within the follower member in the intended orientation, the threaded shaft member initially threadably engages the threaded insert at the desired circumferential position. This may, in turn, ensure that the stops of the threaded shaft member and the follower member engage each other at the desired stop position for the covering. Accordingly, an accurate clocking of the threads of the threaded insert relative to the follower member can be achieved each and every time the components are assembled together, thereby simplifying the assembly process and ensuring desired operation of the resulting covering. Moreover, when a precision molding technique is used to form the threaded insert, the clocking of the threads may be even more accurately controlled.

Additionally, in one embodiment, the threaded insert and the follower member include corresponding retention features configured to retain the threaded insert within the insertion channel once the insert has been installed therein. For instance, in one embodiment, the threaded insert includes an inclined surface or ramped member extending outwardly from one of its axial ends or end faces that is configured to engage a corresponding retention wall defined by the follower member when the threaded insert is installed within the follower member. Such engagement of the corresponding retention features may inhibit or restrict the threaded insert from backing out or otherwise being unintentionally removed from the insertion channel. Moreover, in one embodiment, the follower member may include retention features (e.g., retention walls) defined along both axial sides of the insertion channel. In such an embodiment, regardless of which axial direction the corresponding retention feature of the threaded insert is facing upon insertion of the insert within the insertion channel, the retention feature of the insert may engage one of the retention features of the follower member.

In one embodiment, the threaded insert has a split-nut configuration. For instance, threaded insert may include first and second nut portions configured to be moved relative to each other into a closed position at which the nut portions collectively define a closed, threaded opening for threadably engaging the threaded shaft member. In one embodiment, the first and second nut portions are hingedly coupled to each other at one end of the threaded insert. For example, a living hinge may be formed between the first and second nut portions to allow such nut portions to be pivoted relative to each other about the hinged connection to the closed position. Additionally, in one embodiment, the first and second nut portions include mating or engagement features at the end of the threaded insert opposite the hinged connection to allow the nut portions to axially engage each other when moved to the closed position. Such mating/engaging features may, for example, serve to prevent or inhibit shearing between the nut portions in the axial direction.

Moreover, in one embodiment, all or a portion of the threaded insert may be formed from a dissimilar type of material than the threaded shaft member such that the internal threads of the threaded insert are formed from a first type of material and the threads of the threaded shaft member are formed from a second type of material. By selecting such dissimilar types of materials to be used at the interface between the threaded insert and the threaded shaft member, the amount of wear occurring on the threads of the threaded insert and/or the threaded shaft member may be reduced significantly. The reduced wear may, in turn, increase the component life(s) of such component(s). Furthermore, the dissimilar types of materials may also reduce the potential for binding of the materials as the threaded shaft member threadably engages the threaded insert.

Additionally, in one embodiment, by providing a separate threaded insert for installation within the follower member, the insert may be configured to define a plurality of internal threads along its axial length for engaging corresponding external threads of the threaded shaft member. In such an embodiment, the threaded engagement between the threaded insert and the threaded shaft member may be significantly more robust as compared to embodiments using only a single or partial thread. Specifically, the various internal threads may allow any loads transferred between the threaded shaft member and the threaded insert to spread out amongst the internal threads of the insert, thereby increasing the load carrying capability of the internal threads and also preventing or minimizing thread wear. Additionally, by providing numerous internal threads for engagement with the threaded portion of the threaded shaft member, the shaft member may track better within the threaded insert, thereby inhibiting or restricting axial "cocking" or displacement of the threaded shaft member relative to the follower member. Moreover, by using a precision molding technique to accurately control the location and size of threads, the threaded engagement between the threaded shaft member and the threaded insert may be more precise.

It should be appreciated that, although the disclosed drive plug assembly will generally be described herein with reference to use of the assembly relative to a threaded shaft member of a power assist module, the drive plug assembly may generally be configured for use in association with any suitable threaded shaft, including any other suitable threaded shaft outside used in association with a covering for an architectural structure.

Referring now to the drawings. FIGS. **1** through **15** illustrate one embodiment of a covering having power assist modules **12** in accordance with aspects of the present subject matter. Specifically, in the illustrated embodiment, the covering is configured as a roller shade **10**. Note that the terms "roller shade" and "shade" are used interchangeably to mean either the entire roller shade assembly **10** or just the light blocking element of the roller shade assembly **10**. The intended meaning should be clear from the context in which it is used.

In the illustrated embodiment of FIG. **1**, the roller shade **10** includes a rotator rail **14** mounted between a bracket clip **16** and a drive mechanism **18**, which provide good rotational support for the rotator rail **14** at both ends. The rotator rail **14**, in turn, provides support for one or more power assist modules **12** located inside the rotator rail **14**, as illustrated the example embodiment of FIG. **2**. The right end of the rotator rail **14** is supported on a tube bearing **30**, which mounts onto the bracket clip **16** as described in more detail later. The left end of the rotator rail **14** is supported on the drive mechanism **18**. The details of the drive mechanism support are shown better in FIG. **17**, in which the drive mechanism **18'** is identical to the drive mechanism **18** of this embodiment and includes a rotating drive spool with an external profile similar to the external profile of the tube bearing **30**. Both the bracket clip **16** and the drive mechanism **18** are releasably secured to mounting brackets (not shown) which are fixedly secured to a wall or to a window frame.

The drive mechanism 18 is described in U.S. Patent Publication No. 2006/0118248 "Drive for coverings for architectural openings," filed Jan. 13, 2006, which is hereby incorporated by reference herein in its entirety for all purposes. FIGS. 116-121 of the '248 publication depict an embodiment of a roller shade **760** with a roller lock mechanism **762**, and the specification gives a complete detailed description of its operation. A brief summary of the operation of this drive mechanism **18** is stated below with respect to FIG. **1** of this specification.

When the tassel weight **20** of the drive mechanism **18** is pulled down by the user, the drive cord **22** (which wraps around a capstan and onto a drive spool, not shown) is also pulled down. This causes the capstan and the drive spool to rotate about their respective axes of rotation. The rotator rail **14** is secured to the drive spool for rotation about the same axis of rotation as the drive spool. As the rotator rail **14** rotates, the shade is retracted with the assistance of the power assist modules **12**, as described in more detail below.

When the user releases the tassel weight **20**, the force of gravity acting to extend the shade urges the rotation of the rotator rail **14** and of the drive spool in the opposite direction from before. This pulls up on the drive cord **22**, which shifts the capstan to a position where the capstan is not allowed to rotate. This locks up the roller lock mechanism so as to prevent the shade from falling (extending).

To extend the shade, the user lifts up on the tassel weight **20** which removes tension on the drive cord **22**, allowing the cord **22** to surge the capstan, unlocking the roller lock mechanism. The drive spool and the rotator rail **14** are then allowed to rotate due to the force of gravity acting to extend the shade. As the shade extends, the power assist modules **12** are wound up in preparation for when they are called to assist in retracting the shade.

There may also be an "overpowered" version of this drive in which pulling down on the tassel weight **20** by the user extends the shade. As the shade extends, the power assist modules **12** are wound up in preparation for when they are called to assist in retracting the shade. When the user releases the tassel weight **20**, the "overpowered" power assist modules **12** urge the shade to rotate in the opposite direction to raise the shade, which shifts the capstan to a position where the capstan is not allowed to rotate. This locks up the roller lock mechanism so as to prevent the shade from rising (retracting). To retract the shade, the user lifts up on the tassel weight **20**, which removes tension on the drive cord **22**, allowing the cord **22** to surge the capstan, unlocking the roller lock mechanism. The drive spool and the rotator rail **14** are then allowed to rotate due to the force of the "overpowered" power assist modules **12** acting to retract the shade.

It should be appreciated that the cord drive **18** described above is simply one example of a drive mechanism that may be used to drive the roller shade **10**. Various other types of drive mechanism are known and may alternatively be used to drive the roller shade **10** in accordance with aspects of the present subject matter.

FIGS. **2** and **3** show the roller shade **10** with the drive mechanism omitted for clarity. In this embodiment, two power assist modules **12** are mounted over a rod **24**. It is understood that any number of power assist modules **12** may be incorporated into a roller shade **10**. It should also be understood that the power assist modules **12** may each have springs **50** (See FIG. **5**) with different spring constants K, and, as explained later, each of the power assist modules **12** may be pre-wound to a desired degree independent of the other power assist modules **12** in the shade **10**. The rod **24** has a non-circular cross-sectional profile (as best appreciated in FIG. 7B) in order to non-rotationally engage various other components as described below. One speed nut **26** is installed onto the rod **24** to prevent the power assist modules **12** from sliding off of the rod **24** (keeping the power assist modules **12** inside the rotator rail **14**). Another speed nut **28** is installed onto the rod **24** near its other end (See also FIGS. **8**, **7**A, and **7**C) to prevent the tube bearing **30** from sliding off of the shaft **32** of the bracket clip **16**, as described in more detail below. Finally, a plunger **34** is used to secure the bracket clip **16** to a wall-mounted or window-frame-mounted bracket (not shown). The rod **24** is not threaded. The speed nuts **26**, **28** have deformable tangs which deform temporarily in one direction, allowing the speed nut to be pushed axially along the rod **24** in a first direction and then to grab onto the rod **24** to resist movement in the opposite direction.

FIGS. **2** and **3** clearly show that, in this embodiment, the rod **24** is shorter than the rotator rail **14** such that the rod **24** does not extend the full length of the rotator rail **14**. In this embodiment, the right end of the rod **24** extends to the bracket clip **16**, where it is secured against rotation, but the left end does not extend all the way to the drive mechanism **18**. If desired, the rod **24** alternatively could be secured against rotation by the drive mechanism **18** and not extend all the way to the bracket clip **16**. As another alternative, the rod **24** could extend the full length of the rotator rail **14** and be secured against rotation both at the drive mechanism **18** and at the bracket clip **16**. As long as one end of the rod **24** is secured against rotation, it is not necessary for the rod **24** to be supported at both ends, because it is supported by the rotator rail **14** at various points along its length, as will be explained in more detail later.

The tube bearing **30** (See FIGS. **3** and **8**) is a substantially cylindrical element including a shaft portion **35** (See FIG. **8**) having an internal surface which defines an inner circular cross-section through-opening **36** and provides rotational support of the tube bearing **30** on the shaft **32** of the bracket clip **16**. The tube bearing **30** has a cylindrical outer surface **38**, which engages and supports the inner surface **54** (See FIG. **15**) of the rotator rail **14**. A shoulder **40** limits how far the tube bearing **30** slides into the rotator rail **14**.

Referring to FIG. **8**, the substantially cylindrical shaft member **32** of the bracket clip **16** defines a non-circular cross-sectional profiled inner bore **112** which receives and engages the rod **24** to support the right end of the rod **24** and prevent it from rotating. A radially-extending flange **114** on the bracket clip **16** defines hooked projections **116** to mount the bracket clip **16** to a wall-mounted or a window-frame-mounted bracket (not shown). Since the bracket clip **16** is stationary relative to the wall or window frame, and since it receives and engages the rod **24** with a non-circular profile, it prevents rotation of the rod **24** relative to the wall or window frame. As mentioned above, the shaft **32** on the bracket clip **16** provides rotational support for the tube bearing **30**.

Referring now to FIGS. **4.5**, and **8**, the power assist module **12** includes a drive plug shaft **42** (which may also be referred to as a threaded follower member **42**), a drive plug **44**, a limiter **46** (which may also be referred to as a threaded shaft member **46**), a spring shaft **48**, a spring **50**, and a spring plug **52**. These components are described in detail below.

Referring to FIGS. **5** and **10**, the spring shaft **48** is a substantially cylindrical, hollow member defining first and second ends and having a plurality of ribs **56** (in this embodiment of the shaft **48** there are four ribs **56** projecting radially outwardly at the 12 o'clock, 3 o'clock, 6 o'clock, and 9 o'clock positions, spaced apart at ninety degree intervals) and extending axially from the first end to the second end. The length of the spring shaft **48** is such that, when assembled onto a power assist module **12** (See FIG. **8**), the distance between the radial flange **58** on the drive plug **44** and the radial flange **60** on the spring plug **52** is slightly longer than the axial length of the spring **50** when the spring **50** is in its relaxed (unwound) state to allow for spring growth as it is prewound.

The ribs **56** not only serve to engage similarly cross-shaped grooves on the limiter **46** and on the spring plug **52**, as described in more detail below; they also provide contact points for the inside surface of the spring **50** to contact the shaft **48**. As the spring **50** is wound up tighter, its inner diameter is reduced and its axial length increases. This may cause some portion(s) of the inner surface of the spring **50** to collapse onto the shaft **48**. The ribs **56** provide an outside perimeter which is sufficient to maintain the spring coaxial with the shaft **48**. This prevents the spring **50** from becoming skewed and interfering with the inner surface of the rotator rail **14**. The ribs **56** also provide a limited number of contact points between the shaft **48** and the inner surface of the spring **50** in order to minimize the frictional resistance between the spring **50** and the shaft **48**.

As described below, the ribs **56** on the spring shaft **48** form a cross-shaped pattern designed to fit into and engage similarly cross-shaped grooves on the limiter **46** and on the spring plug **52**. As best appreciated in FIG. **5**, the spring shaft **48** defines a circular cross-sectional profiled inner bore **78** which both slidably and rotatably receives the rod **24**. It should be noted that the spring shaft **48** need not be supported for rotation relative to the rod **24**. The spring shaft **48** could have an internal cross-sectional profile similar to that of the limiter **46** described below to prevent any rotation between the spring shaft **48** and the rod **24**, but this constraint is not necessary. The spring plug **52** has a non-circular cross-section internal opening **110**, which receives the rod **24** and matches the non-circular cross-section of the rod **24** in order to key the spring plug **52** to the rod **24** so the spring plug **52** does not rotate.

Referring now to FIG. **9**, the limiter **46** (also referred to as the threaded shaft member **46**) is a substantially cylindrical, hollow member. In one embodiment, the limiter **46** may define a cross-shaped groove **62** at a first end **72**. This groove **62** receives the ribs **56** of the spring shaft **48** (See FIG. **10**) such that these two components are locked together from rotation relative to each other, at least long enough to allow a pre-wind to be added to the spring **50** without having to mount the power assist module **12** to a rod **24**, as explained in more detail later.

In one embodiment, a radially-extending shoulder **64** on the limiter **46** may limit how far the spring shaft **48** can be inserted into the limiter **46**. Additionally, the other side of the shoulder **64** may define a stop projection **66** extending axially from the shoulder **64**. As described in more detail later, and depicted in FIG. **10**, the stop **66** impacts against a similar axially-extending stop projection **68** on the drive plug shaft **42** to limit the extent to which the drive plug shaft **42** can be threaded into the limiter **46** (and thus how far the drive plug shaft **42** can be rotated relative to the rod **24** to which the limiter **46** is keyed, as explained below).

Referring to FIG. 7B, the limiter **46** has a non-circular internal cross-sectional profile which matches the non-circular cross-sectional profile of the rod **24**. This allows the limiter **46** to slide axially along the rod **24** while preventing the limiter **46** from rotating relative to the rod **24**. As explained earlier, the rod **24** is secured against rotation relative to the bracket clip **16** by a similar mechanism, and the bracket clip **16** is, in turn, secured to the brackets (not shown) mounted to the wall or to the window frame. Therefore, the rod **24** cannot rotate relative to the wall or to the window frame, and any components that are also secured against rotation relative to the rod **24**, such as the spring plug **52** and the limiter **46**, similarly do not rotate relative to the wall or to the window frame.

Finally, the limiter **46** defines an externally threaded portion **70** (See FIG. **9**) extending from the shoulder **64** to the second end **74** of the limiter **46**. This threaded portion **70** may, in one embodiment, be threaded into an internally threaded portion **76** of the drive plug shaft **42** until the stop projection **66** on the limiter **46** impacts against the stop projection **68** on the drive plug shaft **42**, as illustrated in the example embodiment of FIG. **10**, corresponding to the position where the shade is in the fully retracted position, as discussed in more detail later.

It should be noted that, as the shade **10** is extended, the spring **50** becomes coiled tighter, resulting in a gradual collapse of the diameter of its coils and consequent increase in the overall length of the spring **50**. In a preferred embodiment, the threaded portion **70** of the limiter **46** has a thread pitch such that the drive plug shaft **42** unthreads from the limiter **46** at a rate (controlled by the thread pitch) which is equal to the rate at which the spring **50** "grows" in length as it is coiled tighter as the shade **10** is extended.

Referring back FIG. **9**, the drive plug shaft **42** is a substantially cylindrical, hollow member defining an internally threaded portion **76** and a smooth, cylindrical external portion **80** which is used for rotational support of the drive plug **44** as explained later. One end of the drive plug shaft **42** has a radially extending flange **82** which defines two diametrically opposed flat recesses **84** and a through opening **86** adjacent to one of the flats, the purpose of which is explained later. In the illustrated embodiment, the internally threaded portion **76** is formed integrally with the drive plug shaft **42**. However, in other embodiments, the internal threads may be defined by a separate, threaded insert positioned within the drive plug shaft **42**. For instance, as will be described below with reference to FIGS. **67-69**, a nut or other suitable threaded member may be installed within the drive plug shaft **42** to allow the threaded member to threadably engage the threaded portion **70** of the limiter **46**.

The flange **82** of the drive plug shaft **42** is sized to be received inside the rotator rail **14** (See FIG. **15**), and the flat recesses **84** receive, and are engaged by, the inwardly-projecting and axially extending ribs **88** on the inner surface **54** of the rotator rail **14**. Therefore, as the rotator rail **14** rotates, it causes the drive plug shaft **42** to rotate. When the rotator rail **14** rotates so as to extend the roller shade **10**, the drive plug shaft **42** rotates relative to the limiter **46**, partially unscrewing itself relative to the non-rotating limiter **46** and causing the drive plug shaft **42** to move axially away from (but not to be fully unthreaded from) the limiter **46**. As indicated above, the limiter **46** does not rotate because it is keyed to the rod **24** (which is secured to the wall or window frame via the bracket clip **16**).

Likewise, as the roller shade **10** is retracted, the drive plug shaft **42** threads onto the limiter **46**. This continues until the stop **68** on the drive plug shaft **42** impacts against the stop **66** on the limiter **46**, at which point the drive plug shaft **42**, and therefore also the rotator rail **14** (which is keyed to the drive plug shaft **42** via the flat recesses **84**) are stopped against further rotation. As explained later, the spring **50** will still have some unwinding left in it when the rotator rail is stopped, and this is the degree of "pre wind" which may be added to the power assist module **12** to ensure that the shade is fully retracted.

It should be appreciated that, given the periodic contact between the stop projections **66**, **68** as the roller shade **10** is retracted, the drive plug shaft **42** and the limiter **46** (or at least the portions of such components forming the stop projections **66**, **68**) may be formed from a durable type of material(s) having suitable material properties so as to prevent damage to one or both of the stop projections **66**, **68** as the stop projections **66**, **68** contact each other. For instance, in one embodiment, both the drive plug shaft **42** and the limiter **46** (or at least the portions of such components forming the stop projections **66**, **68**) may be formed from a metal material (e.g., aluminum, steel, or any other suitable metal) such that metal-on-metal contact is provided at the interface between the stop projections **66**, **68** when the roller shade is retracted. As a result, the component life of the drive plug shaft **42** and/or the limiter **46** may be significantly improved as compared to the use of a less durable material(s) for one or both of the stop projections **66**, **68** (e.g., when a plastic-on-metal contact interface is provided between the stop projections **66**, **68**).

Referring now to FIGS. **9** and 7B, the drive plug **44** is a substantially cylindrical, hollow member defining a circular cross-sectional profiled inner bore **90** which is supported for rotation on the circular cross-section portion **80** of the drive plug shaft **42**. The external surface of the drive plug **44** defines a first, frustoconical portion **92** and a second, cylindrical portion **94**, as well as a radially extending flange **96** which is very similar to the flange **82** on the drive plug shaft **42**, including having diametrically opposed flat recesses **98**. The flange **96** also defines an axially-directed projection **100** adjacent to one of the flat recesses **98**. The projection **100** is received in the through opening **86** on the flange **82** of the drive plug shaft **42**, such that, when the drive plug shaft **42** rotates, the drive plug **44** rotates with it. Since the flat recesses **98** on the drive plug **44** are aligned with the flat recesses **84** on the drive plug shaft **42** when the projection **100** is received in the opening **86**, the ribs **88** on the rotator rail **14** are received in and engage both sets of flat recesses **84.98**. Thus, the drive plug shaft **42** and the drive plug **44** both rotate with the rotator rail **14** as the roller shade **10** is extended and retracted. The force required to transfer the rotational torque from the drive plug **44** to the drive plug shaft **42**, especially when the spring **50** is fully wound, is not borne exclusively by the projection **100** on the drive plug **44**, but rather it is shared with, and in fact is borne substantially by, the aligned flat recesses **98**, **84** of the drive plug **44** and drive plug shaft **42**, respectively.

Referring now to FIGS. **4** and **8**, the spring plug **52** is similar to the drive plug **44**, having a first, frustoconical portion **102** and a second, cylindrical portion **104**, and a shoulder **60** which limits how far the spring plug **52** fits into the spring **50**. The first end **106** of the spring plug **52** defines a cross-shaped groove **108**, similar to the cross-shaped groove **62** on the limiter **46**. The cross-shaped groove **108** of the spring plug **52** receives the cross-shaped ribs **56** of the spring shaft **48**. The spring plug **52** defines an inner bore **110** (See FIGS. **4** and **5**) with a non-circular cross-sectional profile that matches the non-circular cross-sectional profile of the rod **24** and keys the spring plug **52** to the rod **24**. Since the rod **24** is secured to the bracket clip **16** against rotation relative to a wall or window frame, and since the spring plug **52** is keyed to the rod **24**, the spring plug **52** is also secured against rotation relative to the wall or window frame, but it may slide axially along the rod **24** if required.

The spring **50** is a coil spring having first and second ends. Referring to FIGS. **11**, **12**, and **13**, the spring **50** is assembled onto the drive plug **44** by lining up the first end of the spring **50** with the frustoconical portion **92** of the drive plug **44**. The spring **50** is then "threaded" onto the drive plug **44** by rotating the spring **50** in a clockwise direction (as seen from the vantage point of FIG. **11**). This "opens up" the spring **50**, increasing its inside diameter and allowing it to be pushed onto and "threaded" up the tapered surface of the frustoconical portion **92** of the drive plug **44**, as illustrated in the example embodiment of FIG. **12**. A final effort to push the spring **50** onto the drive plug **44** places the spring **50** fully onto the cylindrical portion **94** of the drive plug **44**, until the first end of the spring **50** is abutting the flange **96** of the drive plug **44**. When the spring **50** is released (that is, when it is no longer being "opened" by the clockwise rotation against the drive plug **44**), it will collapse, reducing its inside diameter, so it clamps onto the cylindrical portion **92** of the drive plug **44**. The second end of the spring **50** is similarly mounted onto and secured to the cylindrical portion **104** of the spring plug **52** (see FIG. **5**). Note that the frustoconical portions of the drive plug **44** and of the spring plug **52** may be threaded (not shown in the figures) to assist in the assembly of the spring **50** to these plugs **44**, **52**.

To assemble the roller shade **10**, the power assist modules **12** are first assembled as follows. In the illustrated embodiment of FIGS. **9** and **10**, the drive plug **44** is mounted for rotation onto the outer surface **80** of the drive plug shaft **42**, with the flange **96** of the drive plug **44** adjacent to the flange **82** of the drive plug shaft **42** and with the projection **100** of the drive plug **44** not yet inserted into the through opening **86** of the drive plug shaft **42**. The limiter **46** is threaded into the drive plug shaft **42** until the stop projection **66** on the limiter **46** impacts against the stop projection **68** on the drive plug shaft **42**, as illustrated in the example embodiment of FIG. **10**. The spring **50** is then threaded onto the frustoconical portion **92** of the drive plug shaft **42**, as described earlier and as illustrated in the example embodiment of FIGS. **11**, **12**, and finally onto the cylindrical portion **94** of the drive plug shaft **42** as illustrated in the example embodiment of FIG. **13**. One end of the spring shaft **48** is inserted into the spring **50** until its ribs **56** are received in the cross-shaped groove **62** of the limiter **46**. The spring plug **52** is then installed on the other end of the spring **50**, with the groove **108** of the spring plug **52** receiving the ribs **56** of the spring shaft **48** and with the second end of the spring **50** threaded onto the cylindrical portion **104** of the spring plug **52**. Note that so far the rod **24** has not yet been installed. The power assist modules **12** are now assembled as pictured in FIG. **4**.

Referring to FIG. **13**, to "pre-wind" the power assist module **12**, the assembler holds onto the drive plug shaft **42** while rotating the drive plug **44** in a clockwise direction (as seen from the vantage point of FIG. **13**). This causes the spring **50** to start winding up relative to its other end, which is stationary (non-rotating). The other end of the spring **50** is non-rotating because it is secured to the spring plug **52**, which is connected to the spring shaft **48** via the cross-shaped groove **108** on the spring plug **52**, which is engaged with the cross-shaped ribs **56** on the spring shaft **48**. The spring shaft **48** is, in turn, connected to the limiter **46** (as illustrated in the example embodiment of FIG. **10**) via the groove **62** on the limiter **46** which also receives the cross-shaped ribs **56** on the spring shaft **48**. The limiter **46** is prevented from rotation because the stop projection **68** on the drive plug shaft **42** is impacting against the stop projection **66** on the limiter **46**, and the assembler is holding onto the drive plug shaft **42** to prevent its rotation.

It can therefore be seen that, as the assembler rotates the drive plug **44** while holding onto the drive plug shaft **42**, he is winding up the spring **50**. Every time the projection **100** on the drive plug **44** rotates past the through opening **86** on the drive plug shaft **42**, the spring **50** will have one complete turn of "pre-wind" added to it. Once the desired degree of "pre-wind" is reached, the assembler lines up the projection **100** on the drive plug **44** with the opening **86** in the drive plug shaft **42** and snaps the drive plug **44** and the drive plug shaft **42** together as illustrated in the example embodiment of FIG. **14**, with the flange **96** of the drive plug **44** in direct contact with the flange **82** of the drive plug shaft **42** and with the projection **100** of the drive plug **44** extending through the opening **86** in the flange **82** of the drive plug shaft **42**. This "locks" the "pre-wind" onto the power assist module **12**. The power assist module **12** is now assembled and "pre-wound" and is ready for installation in the roller shade **10**. Note that more than one projection **100** on the drive plug **44** and/or more than one opening **86** in the drive plug shaft **42** may be present. In any event, the flats **84** on the drive plug shaft **42** line up with the flats **98** on the drive plug **44** so they may all catch the ribs **88** (See FIG. **15**) of the rotator rail **14**, as explained in more detail below.

From the foregoing discussion, it should be clear that the pre-winding method involves holding one end of the spring **50** to prevent its rotation, while the other end of the spring **50** is rotated. Referring to FIG. **4**, in the pre-wind method described above, the right end of the spring **50** is held against rotation by the spring plug **52** (which is connected to the limiter **46** via the spring tube **48**, all of which are prevented from rotation relative to the drive plug shaft **42**, which is being held stationary by the person who is doing the prewinding. Using this pre-winding method, the spring **50** can only be pre-wound in discrete quantities, such as in one revolution increments for the embodiment depicted in FIG. **9**.

Each power assist module **12** may be "pre-wound" to the desired degree of "pre-wind" independently of the other power assist modules **12** in the roller shade **10**. For instance, some of the power assist modules **12** may be installed with no "pre-wind", while others may have one or more turns of "pre-wind" added to them prior to installation onto the roller shade **10**. It should once again be noted that so far the rod **24** has not yet been installed. However, each power assist module **12** is an independent unit which may be stocked or shipped to an installer already with a desired degree of "pre-wind". This degree of "pre-wind" may be changed by simply separating the drive plug **44** from the drive plug shaft **42** far enough to free the projection **100** on the drive plug **44** from the through opening **86** of the drive plug shaft **42**, which "unlocks" the power assist module **12** so that the degree of "pre-wind" may be adjusted by rotating the drive plug **44** clockwise relative to the drive plug shaft **42** to add more "pre-wind" or by rotating the drive plug **44** counterclockwise relative to the drive plug shaft **42** to reduce the degree of "pre-wind" and then re-inserting the projection **100** on the drive plug **44** through the through opening **86** of the drive plug shaft **42** to again lock the drive plug **44** and drive plug shaft **42** together.

Instead of pre-winding as described above, at the drive plug end of the spring **50**, another alternative is to prewind at the spring plug end of the spring **50**. Referring again to FIGS. **4** and **5**, the user holds onto the spring **50** at its rightmost end, near the spring plug **52**, to prevent the rotation of the spring **50**. He then grasps the flange **60** on the spring plug **52** and rotates it clockwise. This action "opens up" the end of the spring **50**, allowing the spring plug **52** to be rotated while the rightmost end of the spring **50** is held against rotation. Rotation of the spring plug **52** also causes rotation of the spring tube **48**, the limiter **46**, the drive plug shaft **42**, drive plug **44** (which is snapped together for rotation with the drive plug shaft **42**) and the leftmost end of the spring **50** (adjacent the drive plug **44**). Since the user is holding the rightmost end of the spring **50** against rotation, rotation of the left end of the spring **50** by means of rotating the spring plug **52** prewinds the spring **50**. Using this procedure, the spring **50** may be pre-wound any desired amount, including any fractional number of revolutions for an infinitely adjustable degree of pre-wind of the spring **50**. As soon as the user stops rotating the spring plug **52**, the rightmost end of the spring **50** will "collapse" back onto the cylindrical portion **104** of the spring plug **52**, locking onto the spring plug **52** to keep the desired pre-wind on the spring **50**.

It should be noted that, if this alternative pre-wind procedure is used, the two-piece, snap together design of the drive plug shaft **42** and drive plug **44** is not needed and may be replaced by a single piece unit. However, the two-piece design described herein still has another advantage in that it provides an easy way to release any degree of pre-wind on the spring **50** simply by separating the drive plug shaft **42** from the drive plug **44**. As soon as these two parts **42**, **44** are unsnapped and released, the spring **50** will uncoil and lose all its pre-wind.

Referring now to FIGS. **2** and **8**, to assemble the roller shade **10**, the tube bearing **30** is mounted onto the shaft **32** of the bracket clip **16**. The rod **24** is inserted, with a forced interference fit, into the inner bore **112** of the bracket clip **16**, and the speed nut **28** is slid onto the rod **24** (from the left end as illustrated in the example embodiment of FIG. **8**) until it reaches the end of the inner bore **112** of the bracket clip **16**. This prevents the tube bearing **30** from falling off of the bracket clip **16** because the tube bearing shaft **35** cannot pass over the flange of the speed nut **28** at the end of the bracket clip **16**. One or more power assist modules **12** are then installed onto the rod **24** by sliding them onto the left end of the rod **24**. The rod **24** engages the spring plug **52** and the limiter **46** of each power assist module **12** such that they are able to slide axially along the length of the rod **24**, but they are unable to rotate relative to the rod **24**. Since the rod **24** is axially secured to the bracket clip **16** and is prevented from rotating relative to the bracket clip **16**, and since the bracket clip **16** is secured to a bracket which is mounted to a wall or to a window frame, then the rod **24** and the spring plugs **52** and limiters **46** of the power assist modules **12** are all mounted so they do not rotate relative to the wall or window frame.

The spring shaft **48** of each module **12** is both slidably and rotatably supported on the rod **24**. The drive plug shaft **42** is threaded onto the non-rotating limiter **46**, and the drive plug **44** is rotatably supported on the drive plug shaft **42** and is locked for rotation with the drive plug shaft **42** via the projection **100** inserted through the opening **86** on the drive plug shaft **42**.

Once the desired number of modules **12** is slid onto the rod **24**, the speed nut **26** is then slid onto the end of the rod **24** to the desired position, as illustrated in the example embodiment of FIG. **2**, to serve as a stop for the drive plug shaft **42** of the last module **12** by the flange of the speed nut **26** abutting the flange **82** of the drive plug shaft **42**. This keeps the power assist modules **12** from sliding out beyond the rotator rail **14**. The rotator rail **14** is then slid from left to right over the entire subassembly, making sure that the ribs **88** (See FIG. **15**) on the inner surface **54** of the rotator rail **14** are received in the flat recesses **84**, **98** on each drive plug shaft **42** and drive plug **44**, respectively (and in the similar flat recesses on the tube bearing **30**, as illustrated in the example embodiment of FIG. 7C). The rotator rail **14** slides all the way over all the power assist modules **12** and fits snugly over the generally cylindrical outer surface **38** of the tube bearing **30** until it is stopped by the shoulder **40** of the tube bearing **30**. Finally, the cord drive mechanism **18** is installed, which includes a drive spool (not shown) which engages the left end of the rotator rail **14** and causes it to rotate.

As was already described earlier, when the tassel weight **20** of the drive mechanism **18** is pulled down by the user, the drive cord **22** (which wraps around a capstan and onto a drive spool, not shown) is also pulled down. This causes the capstan and the drive spool to rotate about their respective axes of rotation in a first direction in order to retract the shade. The rotator rail **14** is secured to the drive spool for rotation with the drive spool about the same axis of rotation as the drive spool (e.g., like the tube bearing **30**, the drive spool also has flat recesses that receive the internal ribs **88** of the rotator rail **14**). As the rotator rail **14** rotates in the first direction, with the user pulling down on the drive cord **22**, the shade is retracted with the help of the springs **50**. The right end of each spring **50** (from the perspective of FIG. **8**) does not rotate, since the spring plug **52** on which it is mounted does not rotate. The left end of each spring **50** drives the drive plug **44** on which it is mounted and the respective drive plug shaft **42** that is connected to the drive plug **44** by means of the projection **100** and by means of the rotator rail **14**, which has internal ribs **88** that key the rotator rail **14** to all the drive plugs **44** and drive plug shafts **42**. Thus, as the springs **50** drive their respective drive plugs **44**, they drive the rotator rail **14** in the first direction, with the assistance of the user pulling down on the drive cord, which drives the drive mechanism **18** and the rotator rail **14** in the first direction, to retract the shade.

The "pre-wind" in the power assist modules **12** provides force to retract the roller shade **10** all the way until the shade is completely retracted. Once the shade is completely retracted, the stop projection **66** on the limiter **46** impacts against the stop projection **68** on the drive plug shaft **42** to prevent any further rotation of the rotator rail **14**.

When the user releases the tassel weight **20**, the force of gravity acting to extend the shade urges the rotation of the drive spool in the opposite direction. This pulls up on the drive cord **22** which shifts the capstan to a position where the capstan is not allowed to rotate. This locks up the roller lock mechanism so as to prevent the shade from falling (extending).

To extend the shade, the user lifts up on the tassel weight **20**, which relieves tension on the drive cord **22**, allowing the cord **22** to surge the capstan (as described in US 2006/0118248, which was previously incorporated by reference herein). The drive spool and the rotator rail **14** are then allowed to rotate in a second direction due to the force of gravity acting to extend the shade, overcoming the force of the power assist modules **12**. This causes the power assist modules **12** to wind up in preparation for when they are called to assist in retracting the shade again. When the user releases the tassel weight **20** again, the gravitational force acting on the tassel weight **20** puts enough tension on the drive cord **22** to prevent any further surging of the capstan, which locks the roller lock mechanism and locks the roller shade in place (as indicated earlier, other alternative cord operated locking mechanisms could be used).

It should be noted that, in the above-described embodiment(s) of the roller shade **10**, the rod **24** is supported and secured against rotation by the non-drive end bracket clip **16** (See FIG. **8**). The spring plug **52** is keyed to the rod **24**, so it also is secured for non-rotation to the non-drive end bracket clip **16**. The limiter **46** is also keyed to the rod **24**, so it also is secured for non-rotation to the non-drive end bracket clip. As the rotator rail **14** (See FIG. **1**) is extended, its inside surface **54** (See FIG. **15**) engages the drive plug **44** and the drive plug shaft **42** (via the projections **88** which engage the flats **84**, **98** (See FIG. **14**) of the drive plug shaft **42** and of the drive plug **44**, respectively. The drive plug shaft **42** threads itself partially off of the limiter **46** as the spring **50** winds up.

When retracting the roller shade **10**, the rotator rail **14** is urged to rotate by the spring **50** so as to unwind the spring **50**, and this action re-threads the drive plug shaft **42** onto the limiter **46** until the stop **66** on the limiter **46** impacts against the stop **68** on the drive plug shaft **42**, preventing any further rotation of the drive plug shaft **42** and therefore also of the rotator rail **14**, and this corresponds to the fully retracted position of the rotator rail **14**.

Various additional embodiments of the present subject matter will now be described below. It should be appreciated that, in general, such embodiments may operate in substantially the same manner as the embodiment(s) described above, with the following primary differences in implementation of the design:

The rod **24** may be secured against rotation to either the drive end or the non-drive end of the roller shade, whereas the embodiment(s) described above was configured to be secured against rotation to the non-drive end. This may be accomplished, for example, by using a coupler.

- Instead of keying the limiter to the rod **24**, it may be secured via swaging to the spring shaft.
- The spring shaft may have a "C" cross-section, and may preferably be made from a material, such as extruded aluminum, that is torsionally strong enough to handle the torque applied by the spring **50**.
- The rod **24** may only be keyed to a single element (e.g., the spring plug) in each power assist module, which may facilitate the installation of the rod **24** through the power assist modules.
- The designs of the drive plug shaft and of the drive plug may be different from the embodiment(s) described above.
- Rotator rail adaptors may be added at the spring plug end of each power assist module to provide additional support for the rod **24**. These rotator rail adaptors may mount onto, but rotate independently from, their corresponding spring plugs and may accommodate a range of rotator rail sizes (diameters).

FIGS. **16-38** show a second embodiment of a roller shade **10'** made in accordance with the present invention. The same item numbers are used for this second embodiment 10' as were used for the first embodiment 10, with the addition of a "prime" designation (as in **10'**) to differentiate the second embodiment from the first embodiment.

Referring to FIGS. **16-18**, the roller shade **10'** includes a drive mechanism **18'**, which may, for example, be configured the same as the drive mechanism **18** in the first embodiment. However, other alternative drive mechanisms may be used, as known in the art. The roller shade **10'** also includes a rotator rail **14'**, a non-drive end bracket clip **16'**, a rod **24'**, first and second speed nuts **26'**, **28'**, a tube bearing **30'**, a coupler **34'** (See FIG. **18**), and one or more power assist modules **12'**. As explained later, the power assist modules **12'** may include rotator rail adaptors **118'**. It should be noted that the rod **24'** in this embodiment of a roller shade **10'** is secured for non-rotation to the non-drive end bracket clip **16'** via the coupler **34'**. Alternatively, another embodiment of a roller shade **10"** is shown in FIGS. **39-41** that has the rod **24'** secured for non-rotation to the drive mechanism **18'** via the coupler **34'**, as explained in more detail later. In general, the aforementioned components may be configured the same as or substantially similar to their counterparts in the embodiment of the roller shade **10** shown in FIGS. **1-15**, with the exception of the coupler and the rotator rail adaptors (which were absent in the first embodiment 10) and the power assist modules **12'**, which have structural differences but function in substantially the same manner, as explained in more detail below.

Referring to FIGS. **19-26**, each power assist module **12'** includes a drive plug shaft **42'**, a drive plug **44'**, a limiter **46'**, a spring shaft **48'**, a spring **50'**, a spring plug **52'**, and may include a rotator rail adaptor **118'**.

Referring to FIGS. **20** and **28**, the spring shaft **48'** is an elongated element, preferably made from a material, such as extruded aluminum (or other material of sufficient torsional strength), with a "C" channel cross-section (as may also be appreciated in FIGS. **25** and **26**). In the illustrated embodiment of FIGS. **26** and **30**B, the spring plug **52'** defines an inner bore **110'** with a substantially "V" shaped projection **108'** which, as best appreciated in FIG. **26**, is received in the substantially "V" shaped notch **56'** in the "C" channel cross-section of the spring shaft **48'**, and in the substantially "V" shaped notch **57'** of the rod **24'** such that the spring plug **52'**, spring shaft **48'** and rod **24'** are locked together for non-rotation. To summarize, the "V" shaped projection **108'** of the spring plug **52'** extends through both the "V" shaped notch **56'** in the "C" channel cross-section of the spring shaft **48'** and the "V" shaped notch **57'** of the rod **24'**, locking all three of the items for non-rotation relative to each other.

The spring shaft **48'** is further secured to the spring plug **52'** via a screw **53'** (See also FIGS. **20**, **26** and **30**B) which is threaded between the inner bore **110'** of the spring plug **52'** and the outer surface of the spring shaft **48'** to lock these two parts **52'**, **48'** together against separation in the axial direction.

In the illustrated embodiment of FIGS. **25**, **27** and **28**, the other end of the spring shaft **48'** fits into the inner bore **72'** of the limiter **46'**, with the substantially "V" shaped projection **62'** of the limiter **46'** fitting into the substantially "V" shaped notch **56'** in the "C" channel cross-section of the spring shaft **48'**, such that both of these parts **46'**, **48'** are locked together for non-rotation relative to each other, as illustrated in the example embodiment of FIG. **25**.

Referring now to FIGS. **36-38**, the limiter **46'** includes a thinned-out spot **120'** to indicate the location where the spring shaft **48'** may be hit in the radial direction with a center punch **122'**, punching through the limiter **46'** to swage the spring shaft **48'** against the substantially "V" shaped projection **62'** of the limiter **46'** to lock these two parts **46'**, **48'** together so they will not slide relative to each other in the axial direction.

Thus, the assembly of the spring plug **52'**, the spring shaft **48'**, and the limiter **46'** is secured together for non-rotation relative to each other as well as for non-separation in the axial direction. In this assembly, only the spring plug **52'** engages the rod **24'** during final assembly (as illustrated in the example embodiment of FIG. **26**) to prevent rotation of the assembly relative to the rod **24'**, but the assembly permits sliding motion of the spring plug **52'**, spring shaft **48'** and limiter **46'** in the axial direction relative to the rod **24'**. As explained in more detail later, the rod **24'** is secured for non-rotation either to the non-drive end bracket clip **16'** or to the drive mechanism **18'** via a coupler **34'**.

Referring now to FIGS. **27-29**, the drive plug **44'** is similar to the drive plug **44** of the described above, with flats **98'** which receive and engage the ribs **88** (See FIG. **15**) of the rotator rail **14** for positive rotational engagement of these two parts **44'**, **14**. The inner bore **90'** of the drive plug **44'** is supported for rotation by the smooth external surface **80'** of the drive plug shaft **42'**. The drive plug **44'** defines a hook **100'** which snaps over a projection **86'** on the drive plug shaft **42'** to lock these two parts together (in the assembled position of FIG. **29**) after the desired degree of "pre wind" has been added to the power assist module **12'**, so as to "lock" the degree of pre-wind in a similar manner to how this was handled in the embodiment of the roller shade **10** described above. The drive plug shaft **42'** has corresponding flats **84'** which align with the flats **98'** of the drive plug **44'** and receive the ribs **88** of the rotator rail **14** such that both the drive plug shaft **42'** and the drive plug **44'** together engage the rotator rail **14**.

As was the case for the embodiment(s) described above, the limiter **46'** includes a stop **66'** (See FIG. **27**) which impacts against a stop **68'** on the drive plug shaft **42'** when the shade is in the fully retracted position to stop the shade from further rotation, despite the fact that the power assist modules **12'** may continue to urge the rotator rail **14'** to rotate in the retracting direction. Similar to the embodiment(s) described above, it may be desirable to form the drive plug shaft **42'** and the limiter **46'** (or at least the portions of such components forming the stop projections **66'**, **68'**) from a durable type of material(s) having suitable material properties so as to prevent damage to one or both of the stops **66'**, 68' as the stops 66', 68' contact each other. For instance, in one embodiment, both the drive plug shaft 42' and the limiter 46' (or at least the portions of such components forming the stops 66', 68') may be formed from a metal material (e.g., aluminum, steel, or any other suitable metal) such that metal-on-metal contact is provided at the interface between the stops 66', 68' when the roller shade 10' is retracted.

Additionally, similar to the embodiment described above, the drive plug shaft 42' is configured to be threaded onto the limiter 46'. In one embodiment, the drive plug shaft 42' may include integrally formed, internal threads configured to engage the corresponding threaded portion of the limiter 46'. Alternatively, as will be described below with reference to FIGS. 67-69, the internal threads may be defined by a separate, threaded insert positioned within the drive plug shaft 42'.

Referring to FIGS. 30A-30C, the rotator rail adaptor 118' is a planar, generally rectangular element defining opposed flats 124'. It also defines a central through opening 126' which rides over the stub shaft 128' of the spring plug 52' and permits relative rotation between the rotator rail adaptor 118' and the stub shaft 128'. The stub shaft 128' defines an axial shoulder 130' which serves to lock the rotator rail adaptor 118' in the axial direction, to prevent it from slipping axially off of the spring plug 52'. The axial shoulder 130' tapers from a smaller diameter at the end of the stub shaft 128' to a larger diameter at its inner end. During assembly, the shoulder 130' flexes just enough to allow the rotator rail adaptor 118' to slide over the axial shoulder 130' during assembly, and then the shoulder 130' snaps back to its original position to rotationally lock the rotator rail adaptor 118' in place as illustrated in the example embodiment of FIG. 30C.

FIGS. 33-34 show how the rotator rail adaptor 118' engages two different sizes of rotator rails 14', and FIG. 35 shows how a larger rotator rail adaptor 119 engages a still larger rotator rail 14'. As may be appreciated in FIG. 33, the rotator rail adaptor 118' engages the ribs 88' of the rotator rail 14'. This represents the smallest diameter rotator rail 14', which, in this particular embodiment, is a 1 inch diameter rotator rail. FIG. 34 shows the same rotator rail adaptor 118' installed in a slightly larger diameter rotator rail 14', in this case a 1½ inch diameter rotator rail. Again, the flats 124' of the rotator rail adaptor 118' engage the ribs 88' of this larger diameter rotator rail 14' which extend inwardly to the same position as the ribs 88' on the smaller diameter rotator rail 14'. The rotator rail adaptor 118' provides a bridge by which the rotator rail 14' supports the spring plug 52', which in turn supports the rod 24' (See FIG. 23), which supports the power assist module 12'.

Each power assist module 12' is supported at a first end by the drive plug 44' and the drive plug shaft 42' and at a second end by the spring plug 52'. Since the flats 98' of the drive plug 44' (See FIG. 27) and the flats 124' of the rotator rail adaptor 118' (See FIG. 33) engage the ribs 88' of the rotator rail 14', the rotator rail 14' supports the drive plug 44' and rotates with the drive plug 44' and with the rotator rail adaptor 118'. If two power assist modules 12' are located close together, as shown, for example, in FIG. 22, it may not be necessary to have a rotator rail adaptor 118' on the second end of one power assist module 12' (for example on the second end of the module on the left in FIG. 22), because the rod 24' is adequately supported by the drive plug 44' at the first end of the adjacent power assist module 12' (for example, the drive plug 44' of the module 12' on the right in FIG. 22). FIG. 22 does show the use of a rotator rail adaptor 118' at the second end of the power assist module 12' on the left, but it would not be necessary in this instance. Note that the rotator rail adaptor 118' shown in FIG. 23 also may not be necessary, since the rod 24' of the power assist module 12' is adequately supported by the shaft 132' of the nearby bracket clip 16'.

FIGS. 31, 32, and 35 show a second, larger rotator rail adaptor 119' which is used for an even larger rotator rail 14', which, in this embodiment, is two inches in diameter. This second rotator rail adaptor 119' snaps over and locks onto the first rotator rail adaptor 118' with the aid of the hooks 131'. The second rotator rail adaptor 119' is a planar, elongated member defining flats 125' and a central through opening 127' which slides over the stub shaft 128' of the spring plug 52', which allows the second rotator rail adaptor 119' to rotate together with the first rotator rail adaptor 118'. As best illustrated in FIG. 35, the flats 125' of the second rotator rail adaptor 119' engage the ribs 88' of this larger diameter rotator rail 14'.

FIGS. 18 and 23 show the coupler 34' which, in this embodiment, secures the rod 24' for non-rotation relative to the non-drive end bracket clip 16'. As indicated above, FIGS. 39-41 show another embodiment of a roller shade 10" in which the same coupler 34' is used to secure the rod 24' to the mechanism 18' at the drive end of the roller shade. The use of the coupler 34' to secure the rod 24' to the mechanism 18' at the drive end of the roller shade will be described first.

Referring to FIGS. 39-41, the coupler 34' is a sleeve defining an axial through-opening 138' which receives both the rod 24' and at least a portion of a shaft 132' projecting from the mechanism 18'. The shaft 132' has an internal cross-sectional profile which matches up with and receives the non-circular, V-notch profile of the rod 24' for positive engagement between these two parts. The coupler 34' also defines a radially-directed threaded opening 136' which is aligned with an opening 132A' in the shaft 132'. (See FIG. 41) A securing screw 134' is threaded into the threaded opening 136' of the coupler 34' and through the opening 132A' in the shaft 132' and presses against the rod 24', pressing the V-notch of the rod 24' against the corresponding V-projection in the inner surface of the shaft 132'. This securely locks the rod 24' to the mechanism 18', preventing both rotational and axial motion (sliding motion) of the rod 24'. As may be seen in FIGS. 18 and 23, the same coupler 34' is used to securely lock the rod 24' to the non-drive end bracket clip 16', preventing both rotational and axial motion of the rod 24'.

From the above description, one of ordinary skill in the art will appreciated that the embodiments of the shades 10' and 10" operate in substantially the same manner as the shade 10 described initially. The most substantial functional differences are the use of the coupler 34' to make it possible to secure the rod to either end of the shade and the design of the power assist modules so that only the spring plug 52' needs to line up with the V-notch of the rod 24' during assembly, with all the other components of the power assist module 12' being secured to the spring plug 52', thereby facilitating the assembly of the power assist modules 12' onto the rod 24'.

Referring now to FIGS. 42 and 43, another embodiment of a power assist module 12* is illustrated in accordance with aspects of the present subject matter. In general, the power assist module 12* is similar to the power assist module 12' of FIGS. 19 and 20, but it incorporates a second limiter 140*, as described in more detail below.

Referring to FIGS. 43-45, it may be appreciated that the drive plug shaft 42* and the drive plug 44* are slightly different from the drive plug shaft 42' and the drive plug 44' of FIGS. **19** and **27**. The drive plug shaft **42*** and the drive plug **44*** are shorter, but serve the same function as the earlier-described embodiments. Namely, in this embodiment 12*, the drive plug shaft **42*** (See FIGS. **44** and **45**) has a first axially-extending stop projection **68*** which impacts against the shoulder **66*** of the limiter **46*** to limit the extent to which the drive plug shaft **42*** can be threaded into the limiter **46*** (and thus how far the drive plug shaft **42*** can be rotated relative to the rod **24'** to which the limiter **46*** is keyed, as explained above with respect to the power assist module **12'** of FIG. **20**). The drive plug shaft **42*** has ears that extend through and snap into slots in a roller tube adapter **42**A*, which has recesses that receive the projections from the rotator rail **14** so that the drive plug shaft **42*** and roller tube adapter **42**A* rotate with the rotator rail **14**.

In this embodiment of the power assist module **12***, the shoulder **68*** of the drive plug shaft **42*** works in conjunction with the shoulder **66*** of the limiter **46*** to act as a top stop, limiting how far the roller shade **10** can be raised. As explained with respect to the previous embodiment 12', as the shade **10** is raised, the drive plug shaft **42*** threads onto the limiter **46*** until the shoulder **68*** on the drive plug shaft **42*** impacts against the shoulder **66*** of the limiter **46*** to bring the shade **10** to a stop. The drive plug **44*** may be briefly separated from the drive plug shaft **42*** and rotated about the longitudinal axis of the limiter **46*** to adjust the amount of "pre-wind" on the shade **10** and then snapped back together.

It should be appreciated that, similar to the embodiments described above, it may be desirable to form the drive plug shaft **42*** and the limiter **46*** (or at least the portions of such components forming the stops or shoulders **66***, **68***) from a durable type of material(s) having suitable material properties so as to prevent damage to one or both of the shoulders **66***, **68*** as the shoulders **66***, **68*** contact each other. For instance, in one embodiment, both the drive plug shaft **42*** and the limiter **46*** (or at least the portions of such components forming the shoulders **66***, **68***) may be formed from a metal material (e.g., aluminum, steel, or any other suitable metal) such that metal-on-metal contact is provided at the interface between the shoulder **66***, **68*** when the roller shade **10** is retracted. It should also be appreciated that, similar to the embodiments described above, the internal threads **76*** of the drive plug shaft **42*** may be formed integrally therewith or, as will be described below with reference to FIGS. **67-69**, the internal threads may be defined by a separate, threaded insert positioned within the drive plug shaft **42***.

One difference between the drive plug shaft **42*** of this embodiment and the drive plug shaft **42'** of the previous embodiment is that the drive plug shaft **42*** of this embodiment includes a second axially-extending stop projection **142*** (See FIG. **44**) which impacts against the shoulder **144*** of the second limiter **140*** (also referred to as a locking ring **140***) to limit the extent to which the drive plug shaft **42*** can be threaded out of the limiter **46***, thereby providing a bottom stop as well as a top stop, as explained in more detail below.

Referring to FIGS. **46**A and **48**, the locking ring **140*** is a substantially circular disk defining a threaded central opening **146*** and a slotted opening **148*** extending from the threaded central opening **146*** to the outer, circumferential flange **150*** of the locking ring **140***. It should be noted that the slotted opening **148*** is a convenience feature to allow the locking ring **140*** to be slide-mounted onto the limiter **46*** instead of having to disengage the power assist module **12*** from the shade **10** (which could be done by loosening the screw **152** in the idle end mounting adapter assembly **154** and sliding the rod **24'** out of the idle end mounting adapter assembly **154**, as explained in more detail later).

The circumferential flange **150*** defines the axially-projecting shoulder **144*** as well as a radially-directed, axially-extending prong **156*** which projects inwardly from the circumferential flange **150*** and serves to lock the locking ring **140*** to the locking nut **158***, as explained below.

Referring to FIG. **47-49**, the locking nut **158*** resembles a geared wheel with an inner bore **160*** defining a non-circular cross-sectional profile, including a key **162*** designed to lock onto a slotted keyway **164*** (See FIG. **47**, this slotted keyway is better appreciated in FIG. **50**) which extends axially along the length of the limiter **46***.

FIG. **47** shows the locking ring **140*** abutting the drive plug shaft **42*** such that the shoulder **142*** on the drive plug shaft **42*** is impacting against the shoulder **144*** on the locking ring **140***. To adjust the bottom limiter/locking ring **140***, the locking nut **158*** is first pulled out from the circumferential flange **150*** of the locking ring **140*** as illustrated in the example embodiment of FIG. **47**, sliding out the locking nut **158*** axially along the length of the limiter **46***. This frees the locking ring **140*** to be partially unscrewed along the limiter **46***, away from the drive plug shaft **42***, as illustrated in the example embodiment of FIG. **48**. Every complete turn of the locking ring **140*** equals one complete rotation of the shade **10**. Once the locking ring **140*** has been unscrewed the correct number of turns to equal the desired lower limit of the shade **10**, the locking nut **158*** is reinserted into locking ring **140*** as illustrated in the example embodiment of FIG. **49**, such that one of the geared teeth of the locking nut **158*** engages the prong **156*** of the locking ring **140***, and the key **162*** of the locking nut **158*** engages the slotted keyway **164*** of the limiter **46***. This locks the locking ring **140*** against rotation relative to the limiter **46***, which in turn is locked against rotation relative to the rod **24'** and therefore also relative to the bracket **16** to which the rod **24'** is secured. Now, as the shade **10** is lowered, the drive plug shaft **42*** and the drive plug **44*** rotate together. The inner threads **76*** (See FIG. **44**, but shown more clearly in FIG. **9**, item **76**) of the drive plug shaft **42*** engage the limiter **46***, causing the drive plug **42*** and drive plug **44*** to travel toward the right (as seen from the vantage point of FIG. **49**), until the shoulder **144*** (See FIG. **46**A) on the locking ring **140*** impacts against the shoulder **142*** on the drive plug shaft **42***, bringing any further lowering of the shade **10** to a stop. Note that the limiter **46*** does not rotate as it is keyed against rotation relative to the rod **24'**.

The idle end mounting adapter assembly **154** of FIG. **46**B is substantially similar to the assembled components **16'**, **30'** and **34'** of FIGS. **17** and **18** described in an earlier embodiment and function in substantially the same manner for securing the rod **24'** to the idle end bracket (opposite the drive end) of the shade **10**.

The power assist module **12*** described above can be adjusted by removing the locking nut **158***, unscrewing the locking ring **140***, and then reinstalling the locking nut **158***. If the bottom hem **194** (See FIGS. **56-58**) of the shade **10** still is not in the desired location, the procedure may be repeated until the hem is as close to the desired location as possible. It may not be possible to get the hem to the exact location desired because the locking ring **140*** may only be moved in discreet increments dictated by the position of the key **162*** in the locking nut **158*** relative to the tooth on the locking nut **158*** that engages the prong **156*** on the locking ring **140***.

FIG. **50** depicts the power assist module **12*** of FIG. **42**, but with a vernier coupling and adjusting mechanism **166** for securing the end of the power assist module **12*** to the mounting bracket of the shade **10*** (See FIGS. **56-58**) which allows very fine and infinitely adjustable control of the bottom hem of the shade **10***, without having to remove the shade from the brackets, as described below. Note that the shade **10*** is a "reverse" shade, with the covering material **232** hanging down the room side of the shade instead of the more conventional instance where the covering material hangs down the wall side of the shade. However, it should be noted that the mechanism described herein may be used in either type of installation by simply flipping the shade and all of its components end for end.

As explained in more detail below, this vernier coupling mechanism **166** allows for the rotational repositioning, relative to the end brackets, of the entire non-rotational portion of the shade **10*** by selectively adjusting the angular position of the rod **24'** relative to the mounting bracket **172**. This rotationally repositions both the top and bottom stops to either raise or lower the shade **10***, but only when the input is by the user pushing on the adjustment tabs **228** (See FIG. **56**), not when the input is from the shade **10*** impacting against either of the top or bottom stops.

FIG. **51** is an exploded, perspective view of the coupling mechanism **166** of FIG. **50**. The coupling mechanism **166** has two distinct assemblies; a first portion **168** which mounts to the power assist module **12*** and the tube **14'** (See FIG. **17**) of the shade **10***, and a second portion **170** which mounts to the idle end bracket **172** of the shade **10*** as seen in FIG. **57**.

The first portion **168** includes a coupler **176** and screw **178**, a tube plug **180**, two needle bearings **182**, **184**, and an idle end shaft **186**. The idle end shaft **186** includes a distal, a male spline portion **188**, a smooth tubular section **190** for supporting the tube plug **180** for rotation via the two needle bearings **182**, **184**, and a proximal end portion **192** which is used to secure the idle end shaft **186** to the connecting rod **24'** via the coupler **176** and screw **178** in the same manner that the coupler **34'** (See FIG. **23**) and the screw **134'** secure the rod **24'** to the shaft **132'** of the bracket clip **16'**. Referring to FIG. **57**, the tube **14** of the shade **10*** mounts over and engages the tube plug **180**, with the male spline portion **188** of the idle end shaft **186** in the "bell housing" **196** of the tube plug **180**. The tube plug **180** spins freely with the tube **14** on the idle end shaft **186**.

Referring back to FIG. **51**, the second portion **170** (also referred to as the bracket clip assembly **170**) of the coupling mechanism **166** includes a clutch output housing **198**, a spring **200**, a clutch input **202**, and a bracket clip housing **204**. As explained in more detail below, this bracket clip assembly **170** acts as a clutch assembly which allows the rotation of the clutch output housing **198** in both clockwise and counterclockwise directions, and with it the likewise rotation of the clutch input **202**, which then rotates the rod **24'**. Since the rod **24'** is keyed to the limiter **46***, the limiter rotates likewise, as well as the locking ring **140*** which is also locked to the limiter **46*** via the locking nut **158***.

If, when the limiter **46*** has threaded into the drive plug shaft **42*** until the shoulder **144*** on the locking ring **140*** is impacting against the shoulder **142*** of the drive plug shaft **42***, the clutch output housing **198** is turned in the counter-clockwise direction (as seen from the vantage point of FIG. **56**), all the components connected to it and described above (namely the clutch input **202**, the idle end shaft **186**, the limiter **46***, and the locking ring **140***) will turn with it in the same direction. The shoulder **140*** on the locking ring **140*** pushes against the shoulder **142*** of the drive plug shaft **42*** which causes the tube **14** of the shade **10*** to rotate so as to raise the hem **194**. If instead the clutch output housing **198** is turned in the clockwise direction, all the components rotate likewise and the shoulder **140*** on the locking ring **140*** moves away from the shoulder **142*** of the drive plug shaft **42*** which causes the weight of the cover material **232** of the shade **10*** to rotate the tube **14** of the shade **10*** so as to lower the hem **194**. However, if the clutch input **202** is pushed in either direction (because one of the shoulders **142***, **68*** (See FIG. **44**) of the drive plug shaft **42*** is impacting against the corresponding shoulders **144*** or **66*** of the bottom stop and top stop respectively) the bracket clip assembly **170** locks up and does not allow rotation which brings the shade**10*** to a stop, either at the top or at the bottom as explained in more detail below.

FIG. **52** offers a more detailed, opposite-end perspective view of the bracket clip assembly **170** of FIG. **51**. The clutch output housing **198** is a substantially cylindrical element which defines an internal cavity **206** which is open at both ends. An arcuate rib **208** protrudes into the cavity **206**, as best appreciated in FIGS. **53-55**. This rib **208** defines first and second shoulders **210**, **212** which may press against tangs **214**, **126** respectively of the spring **200**.

The clutch input **202** is also a substantially cylindrical element which has a bore with a female spline **218** (See FIGS. **51** and **53-55**) which receives the male spline **188** of the idle end shaft **186**. The clutch input **202** also has an axially-extending locking rib **220** which defines first and second shoulders **222**, **224** which may press against tangs **214.126** respectively of the spring **200**.

Finally, the bracket clip housing **204** is also a substantially cylindrical element which defines a cavity **226** (See also FIG. **51**) sized to snuggly receive the spring **200**, as well as the clutch input **202** and the rib **208** of the clutch output housing **198**. However, the rest of the clutch output housing **198** slides over and snaps onto the bracket clip housing **204**, as best seen in FIG. **58**.

In the illustrated embodiment of FIGS. **53-55** and as indicated above, the spring **200** fits snugly in the cavity **226** of the bracket clip housing **204**. If one of the shoulders **222**, **224** of the clutch input **202** hits against its corresponding tang **214**, **216** of the spring **200**, the spring **200** expands slightly and locks onto the inner surface of the cavity **226**, preventing rotation of the clutch input **202** when such a rotation is initiated by the "input end" which corresponds to rotation initiated by shade **10*** as it is fully raised or fully lowered.

As best illustrated in FIGS. **53-55**, the rib **208** of the clutch output housing **198** also lies between the tangs **214**, **216** of the spring **200**. If one of the shoulders **210**, **212** of the clutch output housing **198** hits against its corresponding tang **214**, **216** of the spring **200**, the spring **200** collapses slightly and pulls away from the inner surface of the cavity **226** (as may be appreciated in FIGS. **54** and **55**), allowing rotation, not only of the clutch output housing **198**, but also of the spring **200**, the clutch input **202**, and the assembly **168** (but not the bracket clip housing **204**). For instance, in FIG. **55** the shoulder **212** of the clutch output housing **198** impacts against the tang **216** of the spring **200**, which collapses slightly away from the inner surface of the cavity **226** of the bracket clip housing **204**. The tang **216** pushes on the shoulder **224** of the clutch input **202** which therefore also rotates, and with it all the components locked in to the clutch input **202**. The clutch output housing **198** may be rotated by the user by pushing on the tabs **228** (See FIGS. **52** and **56**). Pushing on the tabs **228** in the direction depicted by the screwdriver **230** in FIG. **56** rotates the entire coupler mechanism **166** (but not the housing **204**) in the counterclockwise direction (corresponding to rotation in the clockwise direction in FIG. **54**). This rotates the locking ring **140***, changing the location of the stop **144***, such that, when the shade is fully extended, the stop **144*** on the locking ring **140*** impacts against the stop **142*** on the drive plug shaft **42*** at an earlier position, thereby further limiting the extension of the shade **10***.

Pushing on the tabs **228** in the opposite direction from what is shown in FIG. **56** rotates the entire coupler mechanism **166** in the clockwise direction (corresponding to rotation in the counterclockwise direction in FIG. **55**). This rotates the locking ring **140*** such that the stop **144*** on the locking ring **140*** backs away from the stop **142*** on the drive plug shaft **42***. The weight of the covering material **232** of the shade **10*** causes it to rotate which lowers the hem **194** (such that the stop **142*** on the drive plug shaft **42*** is always abutting the stop **144*** on the locking ring **140***).

To summarize, as long as the input is initiated by the user by pushing on the tabs **228** of the clutch output housing **198**, the coupler mechanism **166** releases the shade **10*** for rotation to adjust the position of the hem **194**. However, if the input is initiated by the shade itself (either because the shoulder **68*** on the drive plug shaft **42*** is impacting the shoulder **66*** on the limiter **46*** (top stop) or because the shoulder **142*** on the drive plug shaft **42*** is impacting against the shoulder **144*** on the locking ring **140*** (bottom stop), then the coupler mechanism **166** locks up, stopping the shade **10*** from further rotation.

Referring now to FIGS. **59**-**65**, another embodiment of a power assist module **12**** (including broken away view of the rotator tube **14**) is illustrated in accordance with aspects of the present subject matter. The power assist module **12**** includes a limiter-end roller tube adapter **42**A**, a combined drive plug/drive plug shaft **44**** (also referred to as a threaded follower member **44****), a limiter **46**** (also referred to as a threaded shaft member **46****), a spring shaft **48****, a spring **50****, a spring plug **52****, and an opposite-limiter-end roller tube adapter **240****. Also included are a locking ring **140*** and a locking nut **158***, both of which were described earlier with respect to a bottom limiter in the power assist module **12*** of FIG. **43**. Comparing the power assist module **12*** of FIG. **43** with the power assist module **12**** of FIG. **59**, it may be appreciated that the power assist module **12**** has a few differences from the module **12***, which can result in reduced manufacturing costs and greater ease of assembly, as discussed below.

In the module **12**** of FIG. **59**, the spring shaft **48**** is a hollow, rolled lock seam tube providing a substantial savings in procurement cost over the previously described spring shafts **48**, **48***. Referring to FIGS. **59** and **60**, the spring shaft **48**** is a hollow cylinder with identical ends **242**, **244**. Identical "T" slot openings **242**T, **244**T are defined adjacent to the ends **242**, **244** of the spring shaft tube **48****.

The limiter **46**** is similar to the limiter **46*** of FIG. **43**, except that it defines a "T"-shaped projection **248** on the circumferential surface of the limiter **46**** adjacent its non-threaded end **246**. As best shown in FIG. **61**, the end **246** of the limiter **46**** slides into the end **242** of the spring shaft **48**** (in the direction of the arrow **250** of FIG. **60**), causing the hollow tubular spring shaft **48**** to expand at the end **242** until the 'T'-shaped projection **248** on the limiter **46**** snaps into the "T" slot **242**T, at which point the end **242** of the spring shaft **48**** springs back to its original, unexpanded shape. The T-shaped projection **248** is then retained within the T-shaped slot **242**T, so the spring shaft **48**** and the limiter **46**** are positively engaged, both against rotation and against axial movement, relative to each other.

It may be noted that the T-shaped projection **248** has a ramped leading edge, for causing the spring shaft **48**** to expand in order to receive the T-shaped projection **248**, and it has an abrupt shoulder on its trailing edge, to help retain the T-shaped projection **248** within the slot **242**T once the projection has been received in the slot.

The spring plug **52**** is similar to the spring plug **52** of FIG. **5** except that it does not have the striations **108**. Instead, the spring plug **52**** defines a hollow shaft **254** and an internal rectangular key **252** (See FIG. **62**). The spring shaft **48**** slides into the hollow shaft **254** of the spring plug **52**** in the direction of the arrow **256** of FIGS. **62** and **63**, allowing the internal rectangular key **252** of the spring plug **52**** to slide into the "T" slot **244**T (See FIG. **63**) of the spring shaft **48****. Note that the key **252** has a rectangular shape; it is not T-shaped like the projection **248** on the limiter **46****. Therefore, the spring plug **52**** is positively engaged for non-rotation relative to the spring shaft **48****, but the spring plug **52**** may readily slide out axially along the "T" slot **244**T of the spring shaft **48****, as discussed later when describing the procedure for pre-winding the power assist module **12****.

Referring now to FIGS. **59** and **64**, the threaded follower member **44**** generally combines the drive plug shaft **42*** and the drive plug **44*** of the embodiment of FIG. **45** into a single component with all of the same operational features except the ability to rotate the drive plug **44*** relative to the drive plug shaft **42*** in order to pre-wind the spring **50***. As explained below, the pre-wind feature is still available in this power assist module **12**** but is done a bit differently. The threaded follower member **44**** is received in the limiter end roller tube adapter **42**A** and they snap together by sliding the limiter end roller tube adapter **42**A** towards the threaded follower member **44**** in the direction of the arrow **258** (See FIG. **64**).

It should be appreciated that, similar to the embodiments described above, the threaded follower member **44**** may include internal threads configured to threadably engage the threaded portion of the limiter **46****. In such an embodiment, the internal threads may be formed integrally with the threaded follower member **44****. Alternatively, as will be described below with reference to FIGS. **67**-**69**, the internal threads may be defined by a separate, threaded insert positioned within the threaded follower member **44****.

It should also be appreciated that several different sizes of the limiter end roller tube adapter **42**A** may be available, each having a different outer diameter of its flange **260** so as to accommodate different size roller tubes **14** (See FIG. **59**). Moreover, the opposite end roller tube adapter **240**** is supported for rotation on the short shaft **262** of the spring plug **52**** (See FIG. **59**). This opposite end roller tube adapter **240**** also is available in several diameter sizes to accommodate different size roller tubes **14**.

In several embodiments, the user assembles the power assist module **12**** by sliding the end **246** of the threaded limiter **46**** into the end **242** of the spring shaft **48**** until the "T"-shaped projection **248** snaps into the T-slot **242**T, locking the limiter **46**** and spring shaft **48**** together. The user then threads the limiter **46**** into the follower member **44**** until the radially-directed face of its axially-extending stop **66**** abuts the corresponding internal, radially-directed face of the axially-extending stop **76**** in the threaded follower member **44****.

It should be appreciated that, similar to the embodiments described above, it may be desirable to form the threaded follower member **44**** and the limiter **46**** (or at least the portions of such components forming the stops **66****, **76****) from a durable type of material(s) having suitable material properties so as to prevent damage to one or both of the stops **66****, **76**** as the stops **66****, **76**** contact each other. For instance, in one embodiment, both the threaded follower member **44**** and the limiter **46**** (or at least the portions of such components forming the stops **66****, **76****) may be formed from a metal material (e.g., aluminum, steel, or any other suitable metal) such that metal-on-metal contact is provided at the interface between the shoulder stops **66****, **76**** when the roller shade **10** is retracted.

The threaded follower member **44**** is snapped into the limiter-end roller tube adapter **42**A**, and a first end of the spring **50**** is extended over the spring shaft **48**** and limiter **46**** and is "screwed" onto the shaft **94**** of the threaded follower member **44****, by rotating the spring to drive it onto the threaded follower member **44****. Then, the user "screws" the second end of the spring **50**** onto the spring plug **52**** in a similar manner as the first end of the spring **50**** was screwed onto the threaded follower member **44****. Note that, at this point the spring plug **52**** is not yet engaged with the spring shaft **48****.

The user uses one hand to hold tightly to the flange **260** of the limiter-end roller tube adapter **42**A**, and the user uses his other hand to rotate the spring plug **52**** at the opposite end of the spring shaft **48**** in the clockwise direction (as seen from the vantage point of FIG. **59**). Since the second end of the spring **50**** is secured to the spring plug **52****, this second end of the spring **50**** rotates with the spring plug **52****. The user continues to rotate the spring plug **52**** until the desired amount of pre-wind on the spring **50**** is reached. Then, the user simply slides the spring plug **52**** in the direction of the arrow **256** (See FIG. **63**) until the key **252** engages the T-slot **244**T in the spring shaft **48****. This prevents the spring **50**** from unwinding relative to the spring shaft **48****, thereby retaining the prewind of the spring **50****.

In a preferred embodiment, the length of the spring **50**** is substantially equal to the length of the power assist module **12**** between the face of the flange **260** of the limiter-end roller tube adapter **42**A** and the face of the flange **264** on the spring plug **52**** when the limiter **46**** is fully threaded into the threaded follower member **44****. This ensures that, once the spring **50**** has been pre-wound and the key **252** is in the T-slot **244**T, the spring tension helps keep the spring plug **52**** in the spring shaft **48**** so as to preserve the pre-wind condition.

The rest of the assembly, including the installation of the locking ring **140*** and the locking nut **158*** and the installation of the power assist module **12**** in the roller shade, is identical to what has already been described in the earlier embodiments. For example, a rod **24** as illustrated in the example embodiment of FIG. **3** is inserted through the limiter **46**** and spring shaft **48**** and through the adapters **42**A** and **240**** and is mounted on the bracket clip **16**. This power assist module **12**** operates in the same manner as the earlier embodiments, with the changes described essentially affecting only the cost of the components and the ease of assembly and of adjustment for the desired degree of pre-wind on the spring **50****.

Referring now to FIGS. **66-69**, one embodiment of a drive plug assembly **43**** suitable for use within a power assist module is illustrated in accordance with aspects of the present subject matter. Specifically, FIG. **66** illustrates a perspective view of the drive plug assembly **43**** exploded away from both the limiter **46**** (also referred to herein as the threaded shaft member) shown in FIGS. **59-61** and one embodiment of a roller tube adapter **42**B** suitable for use with the drive plug assembly **43****. It should be appreciated that, in general, the drive plug assembly **43**** will be described herein with reference to the embodiment of the power assist module **12**** shown in FIGS. **59-65**. However, in other embodiments, various aspects of the drive plug assembly **43**** shown in FIGS. **66-69** may also be incorporated into any of the other power assist modules described above.

As shown, the drive plug assembly **43**** includes both a follower member **45**** and a threaded insert **47**** configured to be received within the follower member **45****. As will be described below, the threaded insert **47**** may be configured to be installed within the follower member **45**** to provide separately formed internal threads **49**** (FIGS. **67-69**) within the follower member **45****. The internal threads **49**** may, in turn, allow the follower member **45**** to be readily threaded onto or relative to the associated limiter **46****. Additionally, when the follower member **45**** is rotated relative to the limiter **46**** (e.g., with rotation of the rotator rail **14**), the follower member **45**** may be moved axially toward and away from the mechanical stop **66**** on the limiter **46**** depending on the direction of rotation via the threaded engagement provided between the threaded insert **47**** and the threaded portion **70**** of the limiter **46****.

In general, the follower member **45**** may be configured similar to the threaded follower member **44**** described above with reference to FIGS. **59-65**, particularly with reference to the follower member **45**** incorporating aspects of the functionality of both the drive plug shafts and the drive plugs described herein. However, it should be appreciated that various aspects of the follower member **45**** shown in FIGS. **66-69** may also be incorporated into any of the individual drive plug shafts described above, such as the drive plug shafts **42**, **42'**, and **42*** configured to be utilized in connection with a separate drive plug.

In several embodiments, the follower member **45**** may be a substantially cylindrical, hollow component defining a shaft opening **51**** extending axially between opposed first and second axial ends **53****, **55**** of the follower member **45**** for receiving the threaded portion **70**** of the associated limiter **46****. In the illustrated embodiment of FIGS. **67-69**, the follower member **45**** includes both a first axial section **57**** and a second axial section **59****, with the first axial section **57**** extending axially from the first end **53**** of the follower member **45**** to a radially extending flange **61**** of the follower member **45**** and the second axial section **59**** extending axially from the flange **61**** to the second end **55**** of the follower member **45****. As particularly shown in FIGS. **66** and **69**, a shoulder or mechanical stop **76**** is provided within the first axial section **57**** of the follower member **45**** that extends radially inwardly into the shaft opening **51****. Similar to the various embodiments described above including stops or shoulders, the stop **76**** may be configured to engage or contact the corresponding shoulder or mechanical stop **66**** on the limiter **46**** in order to limit the extent to which the follower member **45**** can be moved axially relative to the limiter **46****. Specifically, when the disclosed shade is moved to the fully retracted position, the stop **76**** of the follower member **45**** may be configured to impact or contact against the stop **66**** on the limiter **46**** to prevent further movement (e.g., rotation) of the follower member **45**** relative to the limiter **46****.

In several embodiments, given the periodic contact between the stops **66****, **76**** as the roller shade **10** is retracted, the follower member **45**** and the limiter **46**** (or at least the portions of such components forming the stops **66****, **76****) may be formed from a durable type of material (s) having suitable material properties so as to prevent damage to one or both of the stops **66****, **76**** as the stops **66****. **76**** repeatedly contact each other. For instance, in one embodiment, both the follower member **45**** and the limiter **46**** (or at least the portions of such components forming the stops **66****, **76****) may be formed from a metal material (e.g., aluminum, steel, or any other suitable metal) such that metal-on-metal contact is provided at the interface between the stops **66****, **76**** when the roller shade is retracted. As a result, the component life of the follower member **45**** and the limiter **46**** may be significantly improved as compared to the use of a less durable material (s) for one or both of the stops **66****, **76**** (e.g., when a plastic-on-metal contact interface is provided between the stops **66****, **76****). It should be appreciated that, when forming the follower member **45**** and the limiter **46**** from a metal material, the components may both be formed from the same metal material or from differing metal materials. For instance, in one embodiment, the follower member **45**** may be formed from aluminum while the limiter **46**** may be formed from steel.

Additionally, in one embodiment, one or more radially outwardly projecting features or external ribs may be provided on the second axial section **59**** of the follower member **45****. For instance, in the illustrated embodiment of FIGS. **67**-**69**, the follower member **45**** includes first and second radially outwardly extending ribs **63****, **65****, with the ribs **63****, **65**** being spaced apart circumferentially around the second axial section **59**** of the follower member **45**** by approximately 180 degrees. In one embodiment, the external ribs **63****, **65**** may be configured to be received within and/or engage a corresponding feature of the associated roller tube adapter **42**B**. For instance, in the illustrated embodiment of FIG. **66**, the roller tube adapter **42**B** defines opposed slots **67**** configured to receive the opposed ribs **63****, **65**** of the follower member **45****. When the ribs **63****, **65**** of the follower member **45**** are received within the slots **67**** of the roller tube adapter **42**B**, the follower member **45**** may be rotationally coupled to the roller tube adapter **42**B** and, thus, to the associated rotator rail **14**.

It should be appreciated that, similar to the various other adapters described herein, the roller tube adapter **42**B** may be provided in various different sizes or diameters to accommodate different sized rotator rails **14**. Additionally, similar to the adapters described above, the roller tube adapter **42**B** may include one or more recesses **69**** along its outer perimeter that are configured to receive corresponding, inwardly extending projections of the rotator rail **14**, thereby allowing the roller tube adapter **42**B** to be rotationally coupled to the rotator rail **14**.

Moreover, in several embodiments, the threaded insert **47**** of the drive plug assembly **43**** may be configured to be received within a portion of the shaft opening **51**** defined between the axial ends **53****, **55**** of the follower member **45****. For instance, in the illustrated embodiment of FIGS. **68** and **69**, the shaft opening **51**** includes an enlarged portion defined by the second axial section **55**** of the follower member **45**** that forms an insert cavity **71**** coaxially aligned with the remainder of the shaft opening **51**** for receiving the threaded insert **47****. In such an embodiment, the insert cavity **71**** of the follower member **45**** may be shaped, sized, and/or otherwise configured to allow the threaded insert **47**** to be installed or inserted within the shaft opening **51**** at the second axial end **55**** of the follower member **45****. For instance, in one embodiment, the insert cavity **71**** may be sized and/or shape so as to correspond to or match the size and/or shape of the threaded insert **47****. Specifically, in the illustrated embodiment, the threaded insert **47**** defines a hexagonal shape. In such an embodiment and as illustrated in the example of FIG. **68**, the insert cavity **71**** may be configured to define a corresponding hexagonal shaped cavity or opening for receiving the threaded insert **47****. Additionally, in one embodiment, the insert cavity **71**** may be sized such that an interference fit is defined between the follower member **45**** and the threaded insert **47**** when the insert **47**** is installed within the insert cavity **71****. The interface fit can be used to ensure that the threaded insert **47**** remains rotationally engaged with the follower member **45**** during operation of the associated power assist module **12****. Alternatively, the threaded insert **47**** may be coupled within insert cavity **71****, such as by applying an adhesive(s) between the threaded insert **47**** and the follower member **45**** within the insert cavity **71****.

In several embodiments, the threaded insert **47**** may correspond to any suitable component or member that defines a threaded opening **73**** for receiving the threaded portion **70**** of the limiter **46****. For instance, in the illustrated embodiment, the threaded insert **47**** corresponds to a nut defining a threaded opening **73**** having a plurality of internal threads **49**** configured to threadably engage the corresponding external threads **77**** defined on the threaded portion **70**** of the limiter **46****. When the limiter **46**** is inserted within the shaft opening **51**** at the first axial end **53**** of the follower member **45****, the threaded portion **70**** of the limiter **46**** may be received within the threaded opening **73**** of the threaded insert **47****. The threaded connection between the threaded insert **47**** and the threaded portion **70**** of the limiter **46**** then allows the follower member **45**** to move axially relative to the limiter **46**** with rotation of the drive plug assembly **43****.

Additionally, in several embodiments, the threaded insert **47**** and the threaded portion **70**** of the limiter **46**** may be formed from dissimilar types of material such that the internal threads **49**** of the threaded insert **47**** are formed from a first type of material and the external threads **77**** of the limiter **46**** are formed from second type of material. For instance, as indicated above, in one embodiment, the limiter **46**** may be formed from a metal material. In such an embodiment, the threaded insert **47**** may be formed from a dissimilar or non-metal material that is selected to provide sufficient wear resistance for the internal threads **49**** of the threaded insert **47**** while also providing a smooth, threaded engagement between the threaded insert **47**** and the limiter **46****. For example, when the limiter **46**** is formed from a metal material, it may be desirable to form the threaded insert **47**** from a polymer material, such as any suitable lubricious plastic material. In such an embodiment, suitable polymer materials for the threaded insert **47**** may include, but are not limited to, nylon, acetyl, polycarbonate, polyvinyl chloride, and/or the like (including any combinations thereof). In particular, suitable nylon materials may include, but are not limited to, nylon 66 and nylon ST810A.

As indicated above, in one embodiment, both the follower member **45**** and the limiter **46**** may both be formed from a metal material. In such an embodiment, a non-metal threaded insert **47**** may be provided within the follower member **45**** (e.g., as opposed to the follower member **45**** including internal, integrally formed threads) to avoid a metal-on-metal threaded interface between the follower member **45**** and the limiter **46****. As a result, the threaded insert **47**** may provide an effective solution to various issues that may be associated with metal-on-metal threaded interfaces, such as durability and/or wear issues as well as sticking/friction issues. Additionally, the separate threaded insert **47**** may facilitate forming the follower member **45**** from a different, more durable type of material to allow the follower member **45**** to exhibit increased durability, particularly at the location of its mechanical stop **76****.

Moreover, by providing a separate threaded insert **47****, the insert **47**** may be manufactured or formed with more internal threads **49**** along an axial length **79**** (FIG. **68**) of its threaded opening **73**** (e.g., four to five threads) as opposed to forming integral internal threads within the follower member **45**** (which is often limited to only a single or partial thread due to molding limitations and/or other manufacturing issues). As a result, the threaded engagement between the limiter **46**** and the threaded insert **47**** may be significantly more robust as compared to embodiments utilizing a follower member **45**** with an integrally formed thread (or partial thread). Specifically, the numerous internal threads **49**** may allow the loads transferred between the limiter **46**** and the drive plug assembly **43**** to spread out amongst the internal threads **49****, thereby increasing the load carrying capability of the internal threads **49**** and preventing or minimizing thread wear. Additionally, by providing numerous internal threads **49**** for engagement with the threaded portion **70**** of the limiter **46****, the limiter **46**** may track better within the threaded insert **47****, thereby preventing or inhibiting axial "cocking" or displacement of the limiter **46**** relative to the drive plug assembly **43****.

It should be appreciated that, as indicated above, one or more of the aspects or features of the drive plug assembly **43**** may be utilized or incorporated within any of the other embodiments of the power assist modules described herein. For instance, in one embodiment, each drive plug shaft **42**, **42**', and **42*** described above may be configured to accommodate a corresponding threaded insert or may be formed from a durable type of material along with the associated limiter **46**, **46**', **46*** to prevent damage to the corresponding stops. Similarly, the threaded follower member **44**** described above may be configured to accommodate a corresponding threaded insert or may be formed from a durable type of material along with the associated limiter **46**** to prevent damage to the corresponding stops.

Referring now to FIGS. **70**-**75**, another embodiment of a drive plug assembly **43**" suitable for use within a power assist module is illustrated in accordance with aspects of the present subject matter. Specifically, FIG. **70** illustrates the drive plug assembly **43**" exploded away from both the embodiment of the limiter **46**** (also referred to herein as the threaded shaft member) shown in FIGS. **59**-**61** and the embodiment of the roller tube adapter **42**B** shown in FIG. **66**. For purposes of description and without intent to limit, it should be appreciated that, in general, the drive plug assembly **43**" will be described herein with reference to the embodiment of the power assist module **12**** shown in FIGS. **59**-**65**. However, in other embodiments, various aspects of the drive plug assembly **43**" shown in FIGS. **70**-**75** may also be incorporated into any of the other power assist modules described above or into any other suitable power assist module having any suitable configuration. It should also be appreciated that, in further embodiments, the disclosed drive plug assembly **43**" may be configured to be incorporated into or otherwise form part of any other suitable assembly or module, including assemblies or modules other than power assist modules. For instance, in one embodiment, the drive plug assembly **43**" may be configured to be incorporated into any other assembly or module having an externally threaded shaft. In such an embodiment, the externally threaded shaft may form part of a covering for an architectural structure or may be configured for use within any other suitable system or component.

As shown, the drive plug assembly **43**" includes both a follower member **45**", and a threaded insert **47**" configured to be received within the follower member **45**". As will be described below, the threaded insert **47**" may be configured to be installed or inserted within the follower member **45**" to provide one or more separately formed internal threads **49**" (FIGS. **71**, **72**, and **75**) within the follower member **45**". The internal thread(s) **49**" may, in turn, allow the follower member **45**" to be threaded onto or relative to the associated limiter **46****. Additionally, when the follower member **45**" is rotated relative to the limiter **46**** (e.g., with rotation of the rotator rail **14**) about a rotational axis **75**" (FIGS. **70** and **72**-**74**) of the drive plug assembly **43**", the follower member **45**" may be moved in an axial direction (e.g., as indicated by arrows **81**" in FIGS. **70**-**72**) toward and away from the mechanical stop **66**** on the limiter **46**** depending on the direction of rotation via the threaded engagement provided between the threaded insert **47**" and the threaded portion **70**** of the limiter **46****.

In general, the follower member **45**" shown in FIGS. **70**-**74** may include many of the same or similar features to those described above with reference to the follower member **45**** shown in FIGS. **66**-**69**. However, as will be apparent from the description below, the follower member **45**" is configured to accommodate a separate threaded insert in a manner different from the follower member **45**** described above. It should also be appreciated that various aspects of the follower member **45**" shown in FIGS. **70**-**75** may be incorporated into any of the individual drive plug shafts described above, such as the drive plug shafts **42**.**42**', and **42*** configured to be utilized in connection with a separate drive plug.

In several embodiments, the follower member **45**" corresponds to a substantially cylindrical, hollow component defining a shaft opening **51**" extending axially between opposed first and second axial ends **53**", **55**" of the follower member **45**" for receiving the threaded portion **70**** of the associated limiter **46****. For instance, in the illustrated embodiment of FIGS. **70**-**72**, the follower member **45**" includes both a first axial section **57**" and a second axial section **59**", with the first axial section **57**" extending axially from the first end **53**" of the follower member **45**" to a radially extending flange **61**" of the follower member **45**" and the second axial section **59**" extending axially from the flange **61**" to the second end **55**" of the follower member **45**". As particularly shown in FIG. **70**, a shoulder or mechanical stop **76**" is provided within the first axial section **57**" of the follower member **45**" that extends radially inwardly into the shaft opening **51**". Similar to the various embodiments described above including stops or shoulders, the stop **76**" may be configured to engage or contact the corresponding shoulder or mechanical stop **66**** on the limiter **46**** in order to limit the extent to which the follower member **45**" can be moved axially relative to the limiter **46****. Specifically, when the disclosed shade is moved to the fully retracted position, the stop **76**" of the follower member

45" may be configured to impact or contact against the stop 66** on the limiter 46** to prevent further movement (e.g., rotation) of the follower member 45" relative to the limiter 46**.

In several embodiments, similar to the embodiment of the drive plug assembly 43** described above, the follower member 45" and the limiter 46** (or at least the portions of such components forming the stops 66**, 76") may be formed from a durable type of material(s) having suitable material properties so as to prevent damage to one or both of the stops 66**. 76" as the stops 66**, 76" repeatedly contact each other. For instance, in one embodiment, both the follower member 45" and the limiter 46** (or at least the portions of such components forming the stops 66**, 76") may be formed from a metal material (e.g., aluminum, zinc, steel, or any other suitable metal) such that metal-on-metal contact is provided at the interface between the stops 66**, 76" when the roller shade is retracted. It should be appreciated that, when forming the follower member 45" and the limiter 46** from a metal material, the components may both be formed from the same metal material or from differing metal materials. For instance, in one embodiment, the follower member 45" may be formed from aluminum or zinc while the limiter 46** may be formed from steel.

Additionally, similar to the embodiment described above with reference to FIGS. 66-69, in several embodiments, the threaded insert 47" of the drive plug assembly 43" and the threaded portion 70** of the limiter 46** may be formed from dissimilar types of material such that the internal threads 49" of the threaded insert 47" are formed from a first type of material and the external threads 77** of the limiter 46** are formed from second type of material. For instance, in an embodiment in which the limiter 46** is formed from a metal material, the threaded insert 47" may be formed from a dissimilar or non-metal material that is selected to provide sufficient wear resistance for the internal threads 49" of the threaded insert 47" while also providing a smooth, threaded engagement between the threaded insert 47" and the limiter 46**, such as by forming the threaded insert 47" from a polymer material, including any suitable lubricious plastic material (e.g., nylon, acetyl, polycarbonate, polyvinyl chloride, and/or the like (including any combinations thereof)).

It should be appreciated that, in embodiments in which both the follower member 45" and the limiter 46** are formed from a metal material, a non-metal threaded insert 47" may be provided within the follower member 45" (e.g., as opposed to the follower member 45" including internal, integrally formed threads) to avoid a metal-on-metal threaded interface between the follower member 45" and the limiter 46**. As a result, the threaded insert 47" may provide an effective solution to various issues that may be associated with metal-on-metal threaded interfaces, such as durability and/or wear issues as well as sticking/friction issues. Additionally, the separate threaded insert 47" may facilitate forming the follower member 45" from a different, more durable type of material to allow the follower member 45** to exhibit increased durability, particularly at the location of its mechanical stop 76**.

Moreover, similar to the embodiment described above with reference to FIGS. 66-69, one or more radially-outwardly-projecting features or external ribs may, in one embodiment, be provided on the second axial section 59" of the follower member 45". For instance, as particularly shown in FIGS. 70-72, the follower member 45" includes first and second radially outwardly extending ribs 63", 65", with the ribs 63", 65" being spaced apart circumferentially around the second axial section 59" of the follower member 45" by approximately 180 degrees. In one embodiment, the external ribs 63", 65" may be configured to be received within and/or engage a corresponding feature of the associated roller tube adapter 42B**. For instance, in the illustrated embodiment of FIG. 70, the roller tube adapter 42B** defines opposed slots 67** configured to receive the opposed ribs 63", 65" of the follower member 45". When the ribs 63", 65" of the follower member 45" are received within the slots 67** of the roller tube adapter 42B**, the follower member 45" may be rotationally coupled to the roller tube adapter 42B** and, thus, to the associated rotator rail 14.

It should be appreciated that, similar to the various other adapters described herein, the roller tube adapter 42B** may be provided in various different sizes or diameters to accommodate different sized rotator rails 14. Additionally, similar to the adapters described above, the roller tube adapter 42B** may include one or more recesses 69** along its outer perimeter that are configured to receive corresponding, inwardly extending projections of the rotator rail 14, thereby allowing the roller tube adapter 42B** to be rotationally coupled to the rotator rail 14.

Moreover, in several embodiments, the threaded insert 47" of the drive plug assembly 43" may be configured to be received or inserted within a portion of the shaft opening 51" defined by the follower member 45". For instance, as particularly shown in FIG. 72, a nut insertion channel 71" is defined laterally through the second axial section 59" of the follower member 45" that provides access to the internal shaft opening 51" from the exterior or outer perimeter of the follower member 45" at a location between its opposed axial ends 53". 55". Specifically, in the illustrated embodiment, the insertion channel 71" generally provides access to the shaft opening 51" in a direction oriented transverse to both the axial direction 81" and the rotational axis 75" of the drive plug assembly 43" (e.g., in the radial direction indicated by arrow 83" in FIG. 72). As such, the threaded insert 47" may be configured to be inserted from the exterior of the follower member 45" through the insertion channel 71" in the direction transverse to the axial direction 81" (e.g., in the radial direction 83") such that the threaded insert 47" is at least partially received within a portion of the internal shaft opening 51" extending between the first and second axial ends 53", 55" of the follower member 45". As will be described below, by configuring the threaded insert 47" to be received within the insertion channel 71" in the manner described herein, the position of the threaded insert 47" relative to the follower member 45" may be fixed or otherwise maintained, such as by preventing or restricting relative axial movement between the threaded insert 47" and the follower member 45".

It should be appreciated that the insertion channel 71" of the follower member 45" may be shaped, sized, and/or otherwise configured in any suitable manner that allows the threaded insert 47" to be installed or inserted through the channel 71" and into a portion of the shaft opening 51" between the first and second axial ends 53", 55" of the follower member 45". In several embodiments, the shape, size, and/or configuration of the insertion channel 71" may be selected so as to maintain the relative positioning between the threaded insert 47" and the follower member 45" when the threaded insert 47" is received within the insertion channel 71". For instance, the insertion channel 71 may be configured such that the relative positioning between the threaded insert 47" and the follower member 45" is maintained in the axial direction 81" and/or the radial direction 83" when the threaded insert 47" is received within the insertion channel 71".

For instance, in the illustrated embodiment of FIGS. **71-73**, the insertion channel **71"** defines an axial height **85"** (FIG. **72**) between first and second axial retention walls **87"**, **89"** (FIGS. **71** and **72**) formed by opposed axial portions of the follower member **45"** positioned along either axial side of the insertion channel **71"** and a cross-wise width **91"** (FIG. **73**) between opposed first and second sidewalls **93"**. **95"** (FIG. **73**) formed within the interior of the follower member **45"**. In such an embodiment, the axial height **85"** and the cross-wise width **91"** of the insertion channel **71"** may generally be selected based on the corresponding dimensions of the threaded insert **47"** (e.g., an axial height **97"** (FIG. **72**) defined between opposed first and second axial end faces **99"**, **101"** (FIGS. **72** and **75**) of the threaded insert **47"** and a cross-wise width **103"** (FIG. **73**) defined between opposed first and second sides **105"**, **107"** (FIGS. **72** and **73**) of the insert **47"**) so as to provide a desired fit between the follower member **45"** and the threaded insert **47"**. For example, as indicated above, it may be desirable to provide a fit between the follower member **45"** and the threaded insert **47"** that prevents or minimizes relative movement between such components when the threaded insert **47"** is installed within the follower member **45"**, such as by providing a relatively tight or narrow fit between the follower member **45"** and the threaded insert **47"**. For instance, by configuring the insertion channel **71"** to provide a desired fit in the axial direction **81"** between the threaded insert **47"** and the follower member **45"**, the threaded insert **47"** may be trapped or retained axially between the adjacent retention walls **87"**, **89"** of the follower member **45"** positioned along either axial side of the insertion channel **71"**. Such axial retention of the threaded insert **47"** relative to the follower member **45"** may generally provide more reliable performance of the drive plug assembly **43"** during operation of the disclosed shade. For instance, by maintaining a fixed axial position of the threaded insert **47"** relative to the follower member **45"**, the corresponding location of the thread(s) **49"** of the threaded insert **47"** may be more accurately controlled. Such control of the location of the threads **49"** may, in turn, allow for a more constant stop position to be defined for the shade at which the stop **76"** of the follower member **45"** impacts or contacts against the stop **66**** on the limiter **46**** to prevent or restrict further movement (e.g., rotation) of the follower member **45"** relative to the limiter **46****.

It should be appreciated that, in several embodiments, the insertion channel **71"** and/or the threaded insert **47"** may be configured such that the threaded insert **47"** is configured to be inserted through the insertion channel in only a specific orientation, which may eliminate the potential for assembly errors. Specifically, in the illustrated embodiment of FIG. **72**, the threaded insert **47"** generally extends in a lengthwise direction (e.g., the radial direction **83"** when installed in the follower member **45"**) between an insertion or first end **109"** and an opposed trailing or second end **111"**. In one embodiment, the dimensions of the insertion channel **71"** and/or the threaded insert **47"** may be selected so that the insert **47"** is configured to be inserted through the insertion channel **71"** only with the first or insertion end **109"** being initially received within the channel **71"**. For instance, in the illustrated embodiment of FIG. **72**, the threaded insert **47"** defines a length **113"** between its opposed first and second ends **109"**, **111"** that is greater than the cross-wise width **103"** (FIG. **73**) of the insert **37"** defined between its opposed first and second sides **105"**, **107"**. In such an embodiment, by configuring the insertion channel **71"** such that the cross-wise width **91"** (FIG. **73**) of the channel **71"** is less than the length **113"** of the threaded insert **47"**, the insert **47"** is not capable of being inserted through the insertion channel **71"** by presenting one of the cross-wise sides **105"**, **107"** of the insert **47"** for initial insertion within the channel **71"**. Additionally, in the illustrated embodiment of FIG. **73**, the sidewalls **93"**, **95"** of the insertion channel **71"** are tapered or angled slightly inwardly such that the cross-wise width **91"** of the channel **71"** decreases as the channel **71"** extends away from an open end **147"** (FIGS. **72** and **73**) of the channel **71"** and into the interior of the follower member **45"** in the radial direction **83"** towards an opposed closed end **149"** (FIG. **73**) of the channel **71"**. Similarly, the opposed sides **105"**, **107"** of the threaded insert **47"** define complementary, inwardly angled or tapered surfaces such that the cross-wise width **103"** of the insert **47"** decreases as the insert **47"** extends lengthwise in the direction of the first or insertion end **109"** of the threaded insert **47"**. As a result of such tapering cross-wise widths **91"**, **103"**, the second end **111"** of the threaded insert **47"** is prevented from being inserted as the leading end into and through the insertion channel **71"**.

Referring still to FIGS. **70-75**, the threaded insert **47"** may generally correspond to any suitable component or assembly of components that is configured to threadably engage the threaded portion **70**** of the limiter **46****. For instance, in the illustrated embodiment, the threaded insert **47"** defines a threaded opening **73"** (FIGS. **71-73**) having a plurality of internal threads **49"** configured to threadably engage the corresponding external threads **77**** defined on the threaded portion **70**** of the limiter **46****. With the threaded insert **47"** installed within the follower member **45"** (e.g., via the insertion channel **71"**), the limiter **46**** may be inserted within the shaft opening **51"** (e.g., at the first axial end **53"** of the follower member **45"**) to allow the threaded portion **70**** of the limiter **46**** to be received within the threaded opening **73"** of the threaded insert **47"**. The threaded connection provided between the threaded portion **70**** of the limiter **46**** and the threaded insert **47"** may then allow the follower member **45"** to move axially relative to the limiter **46**** with rotation of the drive plug assembly **43"** relative to the limiter **46****.

It should be appreciated that, in embodiments in which the threaded insert **47"** is configured to be installed within the follower member **45"** in only one specific orientation (e.g., with the insertion or first end **109"** of the insert **47"** being initially received within the insertion channel **71"**), the internal threads **49"** of the threaded insert **47"** can be clocked relative to the follower member **45"** to ensure that the desired stop position is obtained for the associated shade. Specifically, the circumferential starting location of the internal threads **49"** at the first and second axial end faces **99"**, **101"** of the threaded insert **47"** may be selected such that, when the insert **47"** is installed within the follower member **45"** in the intended orientation, the threaded portion **70**** of the limiter **46**** initially threadably engages the threaded insert **47"** at the desired circumferential position around the inner circumference of the threaded opening **73"**. Such engagement at the desired circumferential position may, in turn, ensure that the stops **66****, **76"** of the limiter **46**** and the follower member **45"** engage each other at the desired stop position for the shade. Accordingly, by configuring the threaded insert **47"** to be installed within the follower member **45"** in only the intended orientation, an accurate clocking of the internal threads **49"** relative to the follower member **45"** can be achieved each and every time the components are assembled together, thereby simplifying the assembly process and ensuring desired operation of the resulting shade.

As particularly shown in FIGS. **72** and **75**, in several embodiments, the threaded insert **47**" has a split-nut configuration including first and second nut portions **115**", **117**" that are configured to be moved relative to each other into a closed position at which the nut portions **115**", **117**" collectively define the threaded opening **73**" of the threaded insert **47**". Specifically, in several embodiments, the threaded insert **47**" may be configured such that the first and second nut portions **115**", **117**" remain coupled to each other at one end of the insert **47**" while the nut portions **115**", **117**" are movable relative to each other at the opposed end of the insert **47**".

For example, in the illustrated embodiment, the first and second nut portions **115**", **117**" are hingedly coupled to each other at one of the ends of the threaded insert **47**" (e.g., the first end **109**" of the insert **47**") while being movable relative to each other at the opposed end of the threaded insert **47**" (e.g., the second end **111**" of the insert **47**"). Specifically, in the illustrated embodiment of FIG. **75**, a hinged connection is provided at the first end **109**" of the threaded insert **47**" via a living hinge **119**" formed between the first and second nut portions **115**", **117**". In alternative embodiments, any other suitable connection, such as a hinged connection, a pivot joint or similar joint, may be used to hingedly or pivotably couple the first and second nut portions **115**", **117**" to each other. Regardless, given the hinged connection at the first end **109**" of the threaded insert **47**", the first and second nut portions **115**", **117**" may be moved relative to each other between an opened position (e.g., in the illustrated example of FIG. **75**), at which the nut portions **115**", **117**" are spaced apart from each other and do not define a closed opening, and a closed position (e.g., in the illustrated embodiment of FIG. **72**), at which the nut portions **115**", **117**" are positioned adjacent to each other at the second end **111**" of the threaded insert **47**" so as to collectively define the closed threaded opening **73**" for receiving the threaded portion **70**** of the limiter **46****.

Moreover, in several embodiments, the first and second nut portions **115**", **117**" may include one or more corresponding mating or engagement features at the end of the threaded insert **47**" positioned opposite the hinged or coupled connection between the nut portions **115**", **117**" to allow the nut portions **115**", **117**" to be engaged with each other (e.g., interlocked relative to each other) when moved to the closed position. For instance, in the example embodiment of FIGS. **72** and **75**, the threaded insert **47**" includes both a male feature, such as an engagement tab **121**", extending outwardly from an interior face **123**" (FIG. **75**) of the second nut portion **117**" and a female feature, such as an engagement recess **125**", defined relative to a corresponding interior face **127**" (FIG. **75**) of the first nut portion **117**". In such an embodiment, when the first and second nut portions **115**", **117**" are moved to the closed position (e.g., in the illustrated example of FIG. **72**), the engagement tab **121**" is received within the recess **125**" such that the first and second nut portions **115**", **117**" interlock or overlap each other in the axial direction at the second end **111**" of the threaded insert **47**". Such axial interlocking or overlapping of the first and second nut portions **115**", **117**" may serve to prevent shearing between the nut portions **115**", **117**" at such end **111**" of the threaded insert **47**".

It should be appreciated that, in alternative embodiments, the threaded insert **47**" may have any other suitable split-nut configuration. For example, as opposed to the hinged configuration described above, the first and second nut portions **115**", **117**" may correspond to separate components. In such an embodiment, the separate nut portions may, for instance, include corresponding mating or engagement features at each lengthwise end **109**", **111**" of the threaded insert **47**" to couple the nut portions to each other and/or to provide anti-shearing features when the nut portions are moved together to form the threaded opening **73**". In further embodiments, the threaded insert **47**" may have a conventional nut configuration (i.e., a non-split-nut configuration). For instance, the threaded insert **47**" may correspond to a single, integral component having a threaded opening defined therethrough for threadably engaging the threaded portion **70**** of the limiter **46****.

Additionally, it should be appreciated that, by configuring the threaded insert **71**" as a split-nut, the insert **71**" may be manufactured using one or more manufacturing processes that provide for more accurate control of the resulting dimensions and/or features of the component, such as a precision molding process (e.g., an injection molding process). For example, by using a molding process in which the circumferential sections of the internal thread(s) **49**" provided on each nut portion **115**" **117**" are formed separately within the mold, the positioning of the threads **49**" may be more accurately controlled.

Referring still to FIGS. **70**-**75**, the insertion channel **71**" may, in several embodiments, include one or more locating features for ensuring that the threaded insert **47**" has been properly installed within the follower member **45**". For instance, in the illustrated embodiment of FIG. **73**, the insertion channel **71**" includes shoulder stops **129**" extending inwardly from the sidewalls **93**", **95**" of the channel **71**" against which corresponding shoulders **131**" " (FIGS. **72** and **73**) of the threaded insert **47**" are configured to contact when the insert **47**" has been fully installed within the follower member **45**". Additionally, in the illustrated embodiment of FIG. **73**, the insertion channel **71**" includes angled surfaces **133**" extending from the shoulder stops **129**" to an end pocket, recess, or area (referred to herein simply as end pocket **135**" for the sake of convenience without intent to limit) defined at the closed end **149**" of the channel **71**" for receiving the insertion or first end **109**" of the threaded insert **47**". For instance, in the illustrated embodiment, the end pocket **135**" is formed by a hollow portion of the first rib **63**" extending outwardly from the second axial section **59**" of the follower member **45**". In one embodiment, when installing the threaded insert **47**" into the follower member **45**" via the insertion channel **71**", the insert **47**" is configured to be pushed into the channel **71**" until the first end **109**" of the insert **47**" is received within the end pocket **135**" and the insert's shoulders **131**" abut against the shoulder stops **129**". The positive “stop feature” provided by the shoulders **129**", **131**" allows one to detect when the threaded insert **47**" has been properly installed within the follower member **45**". In addition to the positive “stop feature” or as an alternative thereto, as particularly shown in FIGS. **71** and **73**, in one embodiment, the trailing or second end **111**" of the threaded insert **47**" may be configured to be flush or aligned with the outer profile of the follower member **45**" when the threaded insert **47**" is fully inserted within the follower member **45**". In such an embodiment, a person assembling the components can visually assess whether the threaded insert **47**" has been properly installed within the follower member **45**" by determining whether the second end **111**" of the threaded insert **47**" is aligned with the outer profile of the follower member **45**".

Moreover, in several embodiments, the threaded insert **47"** and/or the follower member **45"** may include one or more retention features for retaining the threaded insert **47"** within the insertion channel **71"**, such as features that inhibit or restrict the threaded insert **47"** from backing or falling out of the channel **71"**. For instance, in the embodiment illustrated of FIGS. **72**.**74**, and **75**, the threaded insert **47"** includes an inclined surface or ramped member **137"** extending outwardly from the second axial end face **101"** of the insert **47"**. In such an embodiment, the ramped member **137"** may be configured to engage a corresponding retention feature of the follower member **45"** to retain the threaded insert **47"** within the insertion channel **71"**. Specifically, in the illustrated embodiment of FIGS. **71**, **72**, and **74**, the follower member **45"** defines a retention pocket, area, or recess (referred to herein simply as retention pocket **139"** for the sake of convenience without intent to limit) adjacent to the open end **147"** (FIGS. **71** and **72**) of the insertion channel **71"** that is configured to receive the ramped member **137"** when the threaded insert **47"** is installed within the follower member **45"**. Specifically, as the threaded insert **47"** is inserted into the channel **71"**, the ramped member **137"** initially rides against the portion of the second axial retention wall **89"** defined at the open end **147"** of the channel **71"** until the ramped member **137"** clears the wall **89"** and snaps into or is otherwise received within the retention pocket **139"**. Upon receipt within the retention pocket **139"**, the threaded insert **47"** may be inhibited or restricted from backing or falling out of the insertion channel **71"** via the engagement or contact between the ramped member **137"** and an adjacent retention wall of the retention pocket **139"**. For example, a radially outer wall **141"** (FIG. **74**) of the retention pocket **139"** and the second axial retention wall **89"** may form a retention wall for engaging the ramped member **137"**.

As indicated above, in several embodiments, the threaded insert **47"** is configured to be installed within the follower member **45"** with the insertion or first end **109"** of the insert **47"** being initially received within the insertion channel **71"**. In such embodiments, when the threaded insert **47"** includes a ramped member **137"** positioned only along the second axial end face **101"** of the insert **47"**, the ramped member **137"** may be received within the retention pocket **139"** only when the threaded insert **47"** is installed within the follower member **45"** with the second axial end face **101"** facing towards the second axial end **55"** of the follower member **45"**. To accommodate instances in which the threaded insert **47"** is installed within the follower member **45"** in the opposite orientation (i.e., with the second axial end face **101"** facing towards the first axial end **53"** of the follower member **45"**), the follower member **45"** may, for example, include an additional retention feature for engaging the ramped member **137"** in such opposed orientation within the follower member **45"**. For instance, in one embodiment, the radially inner wall of the follower member **45"** intersecting the insertion channel **71"** at the first axial retention wall **87"** may form or define a retention wall **143"** (FIG. **72**) opposite the retention pocket **139"** that is configured to engage the ramped member **137"** when the threaded insert **47"** is inserted into the insertion channel **71"** with the second axial end face **101"** facing towards the first axial end **53"** of the follower member **45"**. In such an embodiment, a common radius **145"** (FIG. **74**) may be defined between the axis of rotation **75"** of the follower member **45"** and both the retention wall **141"** of the retention pocket **139"** and the opposed retention wall **143"** formed by the inner wall of the follower member **45"**. As such, regardless of whether the threaded insert **47"** is inserted into the insertion channel **71"** with the second axial end face **101"** facing the first axial end **53"** or the second axial end **55"** of the follower member **45"**, the ramped member **137"** may be configured to engage a corresponding retention feature of the follower member **45"** to ensure that the insert **47"** is retained within the insertion channel **71"**. In addition to the embodiment described above (or as an alternative thereto), the threaded insert **47"** may include ramped members extending from each of its axial end faces **99"**, **101"** to retain the insert **47"** within the insertion channel **71"**. Additionally, in a further embodiment, a retention pocket may be defined in or relative to the first axial retention wall **87"** at a location across the insertion channel **71"** from the retention pocket **139"** to provide a retention feature for receiving the ramped member **137"** when the threaded insert **47"** is inserted into the insertion channel **71"** with the second axial end face **101"** facing towards the first axial end **53"** of the follower member **45"**.

It should be appreciated that, by providing a separate threaded insert **47"**, the insert **47"** may be manufactured or formed with more internal threads **49"** along the axial length of its threaded opening **73"** (e.g., four to five threads) as opposed to forming integral internal threads within the follower member **45"** (which is often limited to only a single or partial thread due to molding limitations and/or other manufacturing issues). As a result, the threaded engagement between the limiter **46**** and the threaded insert **47"** may be significantly more robust as compared to embodiments utilizing a follower member **45"** with an integrally formed thread (or partial thread). Specifically, the numerous internal threads **49"** may allow the loads transferred between the limiter **46**** and the drive plug assembly **43"** to spread out amongst the internal threads **49"**, thereby increasing the load carrying capability of the internal threads **49"** and preventing or minimizing thread wear. Additionally, by providing numerous internal threads **49"** for engagement with the threaded portion **70**** of the limiter **46****, the limiter **46**** may track better within the threaded insert **47"**, thereby preventing axial "cocking" or displacement of the limiter **46**** relative to the drive plug assembly **43"**.

Additionally, it should be appreciated that the separate threaded insert **47"** allows for the internal threads **49"** of the drive plug assembly **43"** to be manufactured or formed using more precise techniques than if the internal threads **49"** were formed integrally with the follower member **45"**. For instance, the threaded insert **47"** may be formed from a precision molding process to allow for the circumferential clocking of the internal threads **49"**, as well as the dimensions of the insert **47"** to be more accurately controlled.

It should also be appreciated that, as indicated above, one or more of the aspects or features of the drive plug assembly **43"** may be utilized or incorporated within any of the other embodiments of the power assist modules described herein. For instance, in one embodiment, each drive plug shaft **42**, **42'**, and **42*** described above may be configured to accommodate a corresponding threaded insert. Similarly, the threaded follower member **44**** described above may be configured to accommodate a corresponding threaded insert.

While the foregoing Detailed Description and drawings represent various embodiments, it will be understood that various additions, modifications, and substitutions may be made therein without departing from the spirit and scope of the present subject matter. Each example is provided by way of explanation without intent to limit the broad concepts of the present subject matter. In particular, it will be clear to those skilled in the art that principles of the present disclosure may be embodied in other forms, structures, arrangements, proportions, and with other elements, materials, and components, without departing from the spirit or essential characteristics thereof. For instance, features illustrated or described as part of one embodiment can be used with another embodiment to yield a still further embodiment. Thus, it is intended that the present subject matter covers such modifications and variations as come within the scope of the appended claims and their equivalents. One skilled in the art will appreciate that the disclosure may be used with many modifications of structure, arrangement, proportions, materials, and components and otherwise, used in the practice of the disclosure, which are particularly adapted to specific environments and operative requirements without departing from the principles of the present subject matter. For example, elements shown as integrally formed may be constructed of multiple parts or elements shown as multiple parts may be integrally formed, the operation of elements may be reversed or otherwise varied, the size or dimensions of the elements may be varied. The presently disclosed embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the present subject matter being indicated by the appended claims, and not limited to the foregoing description.

In the foregoing Detailed Description, it will be appreciated that the phrases "at least one", "one or more", and "and/or", as used herein, are open-ended expressions that are both conjunctive and disjunctive in operation. The term "a" or "an" element, as used herein, refers to one or more of that element. As such, the terms "a" (or "an"), "one or more" and "at least one" can be used interchangeably herein. All directional references (e.g., proximal, distal, upper, lower, upward, downward, left, right, lateral, longitudinal, front, rear, top, bottom, above, below, vertical, horizontal, crosswise, radial, axial, clockwise, counterclockwise, and/or the like) are only used for identification purposes to aid the reader's understanding of the present subject matter, and/or serve to distinguish regions of the associated elements from one another, and do not limit the associated element, particularly as to the position, orientation, or use of the present subject matter. Connection references (e.g., attached, coupled, connected, joined, secured, mounted and/or the like) are to be construed broadly and may include intermediate members between a collection of elements and relative movement between elements unless otherwise indicated. As such, connection references do not necessarily infer that two elements are directly connected and in fixed relation to each other. Identification references (e.g., primary, secondary, first, second, third, fourth, etc.) are not intended to connote importance or priority, but are used to distinguish one feature from another.

All apparatuses and methods disclosed herein are examples of apparatuses and/or methods implemented in accordance with one or more principles of the present subject matter. These examples are not the only way to implement these principles but are merely examples. Thus, references to elements or structures or features in the drawings must be appreciated as references to examples of embodiments of the present subject matter, and should not be understood as limiting the disclosure to the specific elements, structures, or features illustrated. Other examples of manners of implementing the disclosed principles will occur to a person of ordinary skill in the art upon reading this disclosure.

This written description uses examples to disclose the present subject matter, including the best mode, and also to enable any person skilled in the art to practice the present subject matter, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the present subject matter is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they include structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

The following claims are hereby incorporated into this Detailed Description by this reference, with each claim standing on its own as a separate embodiment of the present disclosure. In the claims, the term "comprises/comprising" does not exclude the presence of other elements or steps. Furthermore, although individually listed, a plurality of means, elements or method steps may be implemented by, e.g., a single unit or processor. Additionally, although individual features may be included in different claims, these may possibly advantageously be combined, and the inclusion in different claims does not imply that a combination of features is not feasible and/or advantageous. In addition, singular references do not exclude a plurality. The terms "a", "an", "first", "second", etc., do not preclude a plurality. Reference signs in the claims are provided merely as a clarifying example and shall not be construed as limiting the scope of the claims in any way.

What is claimed is:

1. A power assist module for a coveting for an architectural structure, said power assist module comprising:

- a spring;
- a spring shaft extending through said spring;
- a threaded shaft member coupled to said spring shaft and extending in an axial direction; and
- a drive plug assembly coupled to said threaded shaft member for rotation relative thereto, said drive plug assembly comprising:
  - a follower member defining a shaft opening extending in the axial direction between opposed first and second axial ends of said follower member, said shaft opening configured to receive said threaded shaft member, said follower member further defining an insertion channel providing access to the shaft opening in a direction transverse to the axial direction; and
  - a separate threaded insert configured to be inserted through the insertion channel of said follower member such that said threaded insert is at least partially received within a portion of said shaft opening between said first and second axial ends of said follower member, said threaded insert configured to threadably engage a threaded portion of said threaded shaft member such that said follower member is moved axially along said threaded shaft member as said drive plug assembly is rotated relative to said threaded shaft member.

2. The power assist module of claim **1**, wherein said threaded insert is configured to be inserted through the insertion channel of said follower member in the direction transverse to the axial direction.

3. The power assist module of claim **1**, wherein, when said threaded insert is inserted through the insertion channel, said threaded insert is retained axially within said follower member between opposed axial portions of said follower member positioned along either axial side of the insertion channel.

4. The power assist module of claim **1**, wherein said threaded insert includes a retention feature configured to engage a corresponding retention feature of said follower member when said threaded insert is inserted through the insertion channel.

5. The power assist module of claim 4, wherein:

said retention feature of said threaded insert comprises a ramped member extending outwardly relative to an adjacent portion of said threaded insert; and

when said threaded insert is inserted through the insertion channel, said retention features of said follower member engages a portion of said ramped member to retain said threaded insert within said follower member.

6. The power assist module of claim 1, wherein:

said threaded insert includes first and second nut portions; and

said first and second nut portions are configured to be moved relative to each other into a closed position at which said first and second nut portions collectively define a threaded opening for receiving said threaded portion of said threaded shaft member.

7. The power assist module of claim 6, wherein:

said threaded insert extends lengthwise between a first end and a second end of said threaded insert;

said first and second nut portions are hingedly coupled to each other at said first end of said threaded insert; and

said first and second nut portions are configured to engage each other at said second end of said threaded insert when said first and second nut portions are moved to the closed position.

8. The power assist module of claim 7, wherein said first and second nut portions include corresponding mating features configured to engage each other at said second end of said threaded insert when said first and second nut portions are moved to the closed position.

9. The power assist module of claim 1, wherein:

said threaded insert defines one or more internal threads;

said threaded portion of said threaded shaft member defines a plurality of external threads; and

said one or more internal threads of said threaded insert are formed from a dissimilar type of material than said external threads of said threaded shaft member.

10. The power assist module of claim 1, wherein:

said threaded insert extends in a lengthwise direction between a first end and a second end and in a widthwise direction transverse to the lengthwise direction between a first side and a second side; and

at least one of said threaded insert or said insertion channel is dimensioned such that said threaded insert is configured to be inserted through the insertion channel only with said first end of said threaded insert being initially received within the insertion channel.

11. A power assist module for a covering for an architectural structure, said power assist module comprising:

a spring;

a spring shaft extending through said spring;

a threaded shaft member coupled to said spring shaft and extending in an axial direction; and

a drive plug assembly coupled to said threaded shaft member for rotation relative thereto, said drive plug assembly comprising:

a follower member defining a shaft opening extending in the axial direction between opposed first and second axial ends of said follower member, the shaft opening configured to receive said threaded shaft member; and

a separate threaded insert configured to be installed within said follower member such that said threaded insert is at least partially received within a portion of said shaft opening between said first and second axial ends of said follower member, said threaded insert configured to threadably engage a threaded portion of said threaded shaft member such that said follower member is moved axially along said threaded shaft member as said drive plug assembly is rotated relative to said threaded shaft member;

wherein, when installed relative to said follower member, said threaded insert is trapped axially within said follower member between opposed retention walls of said follower member such that said retention walls limit movement of said threaded insert relative to said follower member in the axial direction.

12. The power assist module of claim 11, wherein:

said follower member defines an insertion channel that provides access to the shaft opening in a direction transverse to the axial direction; and

said threaded insert is configured to be inserted through the insertion channel of said follower member such that said threaded insert is at least partially received within a portion of said shaft opening between said first and second axial ends of said follower member.

13. The power assist module of claim 12, wherein said retention walls of said follower member are positioned along opposed axial sides of the insertion channel.

14. The power assist module of claim 12, wherein said threaded insert is configured to be inserted through the insertion channel of said follower member in the direction transverse to the axial direction.

15. The power assist module of claim 11, wherein said threaded insert includes a retention feature configured to engage a corresponding retention feature of said follower member when said threaded insert is installed relative to said follower member.

16. The power assist module of claim 15, wherein:

said retention feature of said threaded insert comprises a ramped member extending outwardly relative to an adjacent portion of said threaded insert; and

when said threaded insert is installed relative to said follower member, said retention feature of said follower member engages a portion of said ramped surface to retain said threaded insert within said follower member.

17. The power assist module of claim 11, wherein:

said threaded insert includes first and second nut portions; and

said first and second nut portions are configured to be moved relative to each other into a closed position at which said first and second nut portions collectively define a threaded opening for receiving said threaded portion of said threaded shaft member.

18. The power assist module of claim 17, wherein:

said threaded insert extends lengthwise between a first end and a second end of said threaded insert;

said first and second nut portions are hingedly coupled to each other at said first end of said threaded insert; and

said first and second nut portions are configured to engage each other at said second end of said threaded insert when said first and second nut portions are moved to the closed position.

19. The power assist module of claim 11, wherein:

said threaded insert defines one or more internal threads;

said threaded portion of said threaded shaft member defines a plurality of external threads; and

said one or more internal threads of said threaded insert are formed from a dissimilar type of material than said external threads of said threaded shaft member.

20. A drive plug assembly for use with a threaded shaft, said drive plug assembly comprising:

a follower member defining a shaft opening extending in an axial direction between opposed first and second axial ends of said follower member; said shaft opening configured to receive the threaded shaft, said follower member further defining an insertion channel providing access to said shaft opening in a direction transverse to the axial direction; and

a separate threaded insert configured to be inserted through the insertion channel of said follower member such that said threaded insert is at least partially received within a portion of said shaft opening between said first and second axial ends of said follower member, said threaded insert configured to threadably engage the threaded shaft such that said follower member is configured to move axially along the threaded shaft as said drive plug assembly is rotated relative to the threaded shaft.

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